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Pfizer Limited
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639267 3001

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation — United Kingdom

4. Title of the invention — METHOD

5. Name of your agent *(if you have one)* — D YOUNG & CO

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Country	Priority application number *(if you know it)*	Date of filing *(day/month/year)*

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11. I/We request the grant of a patent on the basis of this application.

Signature: D YOUNG & CO
Agents for the Applicants

Date: 12 01 00

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12. Name and daytime telephone number of the person to contact in the United Kingdom

Dr C T Harding 023 8063 4816

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METHOD

FIELD OF INVENTION

The present invention relates to a method. In particular, the present invention relates to an assay method.

More in particular, the present invention relates to an assay method for identifying whether a candidate agent can modulate the binding of gp120 to CCR5.

BACKGROUND ART

It is desirable to identify agents that can modulate the interaction of CCR5 and gp120. By way of background information, gp120 is the envelope protein of HIV that is required for viral entry into the target cells and CCR5 is the cellular receptor to the β-chemokines RANTES, Mip-1-α and Mip-1-β. CCR5 has been identified as being an important receptor in HIV infection.

WO-A-98/00535 discloses a method for detecting gp120 binding on the surface of cells bearing a co-receptor. The method uses directly labelled protein. This method requires high affinity interactions (low nanomolar Kd). However, the affinity of gp120 proteins from different HIV strains varies. Hence, it is believed that this method may not be capable or even suitable to identify agents that can modulate the interaction of biologically relevant molecules.

WO-A-96/418884 discloses a method for screening for agents that may inhibit HIV-1 infection. That method utilises an antibody that, in itself, acts as an agent that would perturb CCR5 and gp120 binding. In addition the protein used in the specific examples cannot bind CCR5. Hence, the specific target receptors are not CCR5.

WO-A-97/37005 discloses an assay method for detecting and preventing HIV infection. The assay described detects fusion of cells expressing gp160 with cells expressing CD4 and CCR5. It is believed that this assay has inherent problems as containment and reagent provision issues would restrict the use of the method for high-throughput screening, particularly on a large scale.

US-A-5928881 discloses an assay that enables identification of CCR5 inhibitors. The assay requires directly labelled chemokine RANTES. We believe that this assay would not always be predictive of binding of gp120.

The present invention seeks to provide an effective assay method, readily adaptable to high throughput screening format, for identifying agents that would modulate medium to low affinity interactions of CCR5 with gp120.

SUMMARY ASPECTS OF THE PRESENT INVENTION

The present invention is based on the finding that *in vivo* the interaction of CCR5 with gp120 may be fairly weak. In this regard, our work with recombinant proteins suggests that the dissociation constant (Kd) of the interaction can be in the 10^{-7}M to 10^{-6}M range. This is contrast to the 10^{-9}M range described by others in model systems and in, for example, the patent applications cited above (e.g. WO-A-98/00535 and references within).

The assay method of the present invention utilises this finding. It enables detection of such weak interaction.

For some applications, the assay method of the present invention may be described as being a competitive binding study between a candidate agent and the gp120/CCR5 combination.

DETAILED ASPECTS OF THE PRESENT INVENTION

In one aspect, the present invention relates to an assay method for determining whether an agent is capable of modulating the interaction of CCR5 with gp120; the method comprising: incubating the agent with CCR5 and gp120 to form a first reaction mixture; and determining whether said agent modulates the interaction of CCR5 with gp120; wherein said gp120 is associated with CD4; and wherein said interaction is a low affinity binding.

In another aspect, the present invention relates to an agent identified by the method according to the present invention, wherein said agent is capable of modulating the interaction of CCR5 with gp120.

In a further aspect, the present invention relates to a process comprising the steps of: (a) performing the assay according to the present invention; (b) identifying one or more agents that are capable of modulating the interaction of CCR5 with gp120; and (c) preparing a quantity of those one or more identified agents.

In a further aspect, the present invention relates to a method of affecting the *in vivo* interaction of CCR5 with gp120 with an agent; wherein the agent is capable of modulating the interaction of CCR5 with gp120 in an *in vitro* assay method; wherein the *in vitro* assay method is the assay method according to the present invention.

In a further aspect, the present invention relates to the use of an agent in the preparation of a pharmaceutical composition for the treatment of a disease or condition associated with the interaction of CCR5 with gp120, wherein the agent is the agent according to the present invention and/or wherein the agent is capable of modulating the interaction of CCR5 with gp120 when assayed *in vitro* by the assay method according to the present invention.

In a further aspect, the present invention relates to a method of treating a subject with an agent, wherein the agent is the agent of the present invention and/or wherein the agent is capable of modulating the interaction of CCR5 with gp120 when assayed *in vitro* by the assay method according to the present invention.

For ease of reference, these and further aspects of the present invention are now discussed under appropriate section headings. However, the teachings under each section are not necessarily limited to each particular section.

PREFERABLE ASPECTS

Preferably the method includes the step of adding a ligand to said first reaction mixture to form a second reaction mixture; wherein said ligand is capable of indicating whether said agent has modulated said interaction.

Preferably said ligand has a detectable label.

Preferably said detectable label is a atom or a group capable of emitting fluorescent light.

Preferably said fluorescent atom is Eu^{3+}.

Preferably detection consists of enhancing natural fluorescence of the Eu^{3+} atom by addition of an enhancer solution known to the art.

Preferably said ligand comprises at least a first antibody.

Preferably said first antibody is capable of binding to gp120; and wherein said binding is high affinity binding.

Preferably said first antibody is associated with a detectable label.

Preferably said ligand may comprise a second antibody.

Preferably said second antibody is capable of binding to said first antibody.

Preferably said second antibody is an anti-IgG antibody.

Preferably said detectable label is associated with said second antibody.

Preferably, the agent is capable of adversely modulating the weak binding interaction of CCR5 and gp120.

Examples of adverse modulation include the separation of, the prevention of the binding of, the cleavage of any one or more of, CCR5 and gp120 – and/or changing their folding configuration so that one or more of gp120 and CCR5 is inoperative.

Further examples of adverse modulation include the separation of, the prevention of the binding of, the cleavage of any one or more of, gp120 and CD4 – and/or changing their folding configuration so that one or more of gp120 and CD4 is inoperative.

ADVANTAGES

The present invention has a number of advantages. These advantages will be apparent in the following description.

By way of example, the present invention is advantageous since it provides a commercially useful assay to identify suitable agents that could be used *in vivo* to treat conditions associated with CCR5/gp120 binding.

By way of further example, the present invention is advantageous since the method detects interaction of gp120 with cells that express CCR5 alone.

By way of example, the present invention is advantageous since the method is amenable to high throughput screening (HTS).

AMINO ACID SEQUENCE

As used herein, the term "amino acid sequence" is synonymous with the term "polypeptide" and/or the term "protein". In some instances, the term "amino acid sequence" is synonymous with the term "peptide". In some instances, the term "amino acid sequence" is synonymous with the term "protein".

The amino acid sequence may be prepared isolated from a suitable source, or it may be made synthetically or it may be prepared by use of recombinant DNA techniques.

In one aspect, the present invention provides an amino acid sequence that is capable of acting as a target in an assay for the identification of one or more agents and/or derivatives thereof capable of affecting gp120/CCR5 binding.

NUCLEOTIDE SEQUENCE

As used herein, the term "nucleotide sequence" is synonymous with the term "polynucleotide".

The nucleotide sequence may be DNA or RNA of genomic or synthetic or of recombinant origin. The nucleotide sequence may be double-stranded or single-stranded whether representing the sense or antisense strand or combinations thereof.

For some applications, preferably, the nucleotide sequence is DNA.

For some applications, preferably, the nucleotide sequence is prepared by use of recombinant DNA techniques (e.g. recombinant DNA).

For some applications, preferably, the nucleotide sequence is cDNA.

For some applications, preferably, the nucleotide sequence may be the same as the naturally occurring form for this aspect.

In one aspect, the present invention provides a nucleotide sequence encoding a substance capable of acting as a target in an assay (such as a yeast two hybrid assay) for the identification of one or more agents and/or derivatives thereof capable of affecting the substance in order to modulate CCR5/gp120 binding.

VARIANTS/HOMOLOGUES/DERIVATIVES

In addition to the specific amino acid sequences and nucleotide sequences mentioned herein, the present invention also encompasses the use of variants, homologue and derivatives thereof. Here, the term "homology" can be equated with "identity".

In the present context, an homologous sequence is taken to include an amino acid sequence which may be at least 75, 85 or 90% identical, preferably at least 95 or 98% identical. In particular, homology should typically be considered with respect to those regions of the sequence (such as amino acids at positions 51, 56 and 57) known to be essential for an activity. Although homology can also be considered in terms of similarity (i.e. amino acid residues having similar chemical properties/functions), in the context of the present invention it is preferred to express homology in terms of sequence identity.

Homology comparisons can be conducted by eye, or more usually, with the aid of readily available sequence comparison programs. These commercially available computer programs can calculate % homology between two or more sequences.

% homology may be calculated over contiguous sequences, i.e. one sequence is aligned with the other sequence and each amino acid in one sequence is directly compared with the corresponding amino acid in the other sequence, one residue at a time. This is called an "ungapped" alignment. Typically, such ungapped alignments are performed only over a relatively short number of residues.

Although this is a very simple and consistent method, it fails to take into consideration that, for example, in an otherwise identical pair of sequences, one insertion or deletion will cause the following amino acid residues to be put out of alignment, thus potentially resulting in a large reduction in % homology when a global alignment is performed. Consequently, most sequence comparison methods are designed to produce optimal alignments that take into consideration possible insertions and deletions without penalising unduly the overall homology score. This is achieved by inserting "gaps" in the sequence alignment to try to maximise local homology.

However, these more complex methods assign "gap penalties" to each gap that occurs in the alignment so that, for the same number of identical amino acids, a sequence alignment with as few gaps as possible - reflecting higher relatedness between the two compared sequences - will achieve a higher score than one with many gaps. "Affine gap costs" are typically used that charge a relatively high cost for the existence of a gap and a smaller penalty for each subsequent residue in the gap. This is the most commonly used gap scoring system. High gap penalties will of course produce optimised alignments with fewer gaps. Most alignment programs allow the gap penalties to be modified. However, it is preferred to use the default values when using such software for sequence comparisons. For example when using the GCG Wisconsin Bestfit package (see below) the default gap penalty for amino acid sequences is -12 for a gap and -4 for each extension.

Calculation of maximum % homology therefore firstly requires the production of an optimal alignment, taking into consideration gap penalties. A suitable computer program for carrying out such an alignment is the GCG Wisconsin Bestfit package

(University of Wisconsin, U.S.A.; Devereux et al., 1984, Nucleic Acids Research 12:387). Examples of other software than can perform sequence comparisons include, but are not limited to, the BLAST package (see Ausubel et al., 1999 ibid – Chapter 18), FASTA (Atschul et al., 1990, J. Mol. Biol., 403-410) and the GENEWORKS suite of comparison tools. Both BLAST and FASTA are available for offline and online searching (see Ausubel et al., 1999 ibid, pages 7-58 to 7-60). However it is preferred to use the GCG Bestfit program.

Although the final % homology can be measured in terms of identity, the alignment process itself is typically not based on an all-or-nothing pair comparison. Instead, a scaled similarity score matrix is generally used that assigns scores to each pairwise comparison based on chemical similarity or evolutionary distance. An example of such a matrix commonly used is the BLOSUM62 matrix - the default matrix for the BLAST suite of programs. GCG Wisconsin programs generally use either the public default values or a custom symbol comparison table if supplied (see user manual for further details). It is preferred to use the public default values for the GCG package, or in the case of other software, the default matrix, such as BLOSUM62.

Once the software has produced an optimal alignment, it is possible to calculate % homology, preferably % sequence identity. The software typically does this as part of the sequence comparison and generates a numerical result.

The sequences may also have deletions, insertions or substitutions of amino acid residues which produce a silent change and result in a functionally equivalent substance. Deliberate amino acid substitutions may be made on the basis of similarity in polarity, charge, solubility, hydrophobicity, hydrophilicity, and/or the amphipathic nature of the residues as long as the secondary binding activity of the substance is retained. For example, negatively charged amino acids include aspartic acid and glutamic acid; positively charged amino acids include lysine and arginine; and amino acids with uncharged polar head groups having similar hydrophilicity values include leucine, isoleucine, valine, glycine, alanine, asparagine, glutamine, serine, threonine, phenylalanine, and tyrosine.

Conservative substitutions may be made, for example according to the Table below. Amino acids in the same block in the second column and preferably in the same line in the third column may be substituted for each other:

ALIPHATIC	Non-polar	G A P
		I L V
	Polar – uncharged	C S T M
		N Q
	Polar – charged	D E
		K R
AROMATIC		H F W Y

EXPRESSION VECTORS

The nucleotide sequence for use as the target or for expressing the target can be incorporated into a recombinant replicable vector. The vector may be used to replicate and express the nucleotide sequence in and/or from a compatible host cell. Expression may be controlled using control sequences which include promoters/enhancers and other expression regulation signals. Prokaryotic promoters and promoters functional in eukaryotic cells may be used. Tissue specific or stimuli specific promoters may be used. Chimeric promoters may also be used comprising sequence elements from two or more different promoters described above.

The protein produced by a host recombinant cell by expression of the nucleotide sequence may be secreted or may be contained intracellularly depending on the sequence and/or the vector used. The coding sequences can be designed with signal sequences which direct secretion of the substance coding sequences through a particular prokaryotic or eukaryotic cell membrane.

FUSION PROTEINS

The target amino acid sequence may be produced as a fusion protein, for example to aid in extraction and purification. Examples of fusion protein partners include glutathione-S-transferase (GST), 6xHis, GAL4 (DNA binding and/or transcriptional activation domains) and (-galactosidase. It may also be convenient to include a proteolytic cleavage site between the fusion protein partner and the protein sequence of interest to allow removal of fusion protein sequences. Preferably the fusion protein will not hinder the activity of the target.

The fusion protein may comprise an antigen or an antigenic determinant fused to the substance of the present invention. In this embodiment, the fusion protein may be a non-naturally occurring fusion protein comprising a substance which may act as an adjuvant in the sense of providing a generalised stimulation of the immune system. The antigen or antigenic determinant may be attached to either the amino or carboxy terminus of the substance.

In another embodiment of the invention, the amino acid sequence may be ligated to a heterologous sequence to encode a fusion protein. For example, for screening of peptide libraries for agents capable of affecting the substance activity, it may be useful to encode a chimeric substance expressing a heterologous epitope that is recognized by a commercially available antibody.

CCR5

An essential component of the assay is CCR5.

CCR5 is a chemokine receptor that typically is present on the surfaces of certain cells within the human body.

The term "chemokine", is a contraction of "chemotactic cytokines". The chemokines comprise a large family of proteins which have in common important structural features and which have the ability to attract leukocytes. As leukocyte chemotactic factors, chemokines play an indispensable role in the attraction of leukocytes to various tissues of the body, a process which is essential for both inflammation and the body's response to infection. Because chemokines and their receptors are central to the pathophysiology of inflammatory and infectious diseases, agents which are active in modulating, preferably antagonizing, the activity of chemokines and their receptors, are useful in the therapeutic treatment of such inflammatory and infectious diseases.

The chemokine receptor CCR5 is of particular importance in the context of treating inflammatory and infectious diseases. CCR5 is a receptor for chemokines, especially for the macrophage inflammatory proteins (MIP) designated MIP-1α and MIP-1β, and for a protein which is regulated upon activation and is normal T-cell expressed and secreted (RANTES).

Background teachings on CCR5 may be found in WO-A-97/32019.

The nucleotide sequence encoding same and the amino acid sequence for same are presented in the attached sequence listings.

Background teachings on CCR5 have also been presented by Victor A. McKusick *et al* on http://www.ncbi.nlm.nih.gov/Omim. The following information concerning CCR5 has been extracted from that source.

"Samson et al. (1996) cloned a human C-C chemokine receptor gene from a human genomic DNA library based on its similarity to a murine C-C chemokine receptor clone (MOP020). The human gene, which they designated ChemR13, encodes a 352-amino acid protein (designated CCCKR5 by them) with a calculated molecular mass of 40,600 Da and a potential N-linked glycosylation site. With a set of overlapping lambda clones, they showed that the gene is 17.5 kb from the CMKBR2 gene. The 2 coding regions share 75% DNA and amino acid sequence identity.

Samson et al. (1996) functionally expressed the gene in a stably transfected CHO-K1 cell line. In transfected cells, macrophage inflammatory protein (MIP)-1-α appeared to be the most potent agonist for CCCKR5, with MIP-1-β and RANTES also active at physiologic concentrations. Samson et al. (1996) detected transcript from the gene in a promyeloblastic cell line, which suggested a potential role for the chemokine receptor in granulocyte lineage proliferation and differentiation.

By radiation hybrid mapping, Liu et al. (1996) localized the CCR5 gene (designated CKR5 by them) to chromosome 3p21.

The C-C chemokine receptor CMKBR5 was identified as a coreceptor for the human immunodeficiency virus-1 (HIV-1) by Deng et al. (1996) and Dragic et al. (1996). CMKBR5 and fusin (162643) facilitate the fusion of HIV-1 with the plasma membrane of CD4(+) cells (CD4; 186940). Deng et al. (1996) found that CMKBR5, and not fusin, promotes entry of the macrophage-tropic viruses believed to be the key pathogenic strains in vivo. Dragic et al. (1996) showed that MIP-1-α, MIP-1-β, and RANTES each inhibit infection of CD4(+) cells by primary, nonsyncytium-inducing (NSI) HIV-1 strains at the virus entry stage and also block env-mediated cell-cell fusion. Both groups showed that expression of the CCCKR5 protein renders nonpermissive CD4(+) cells susceptible to infection by HIV-1 strains. Alkhatib et al. (1996) reported similar observations and detected mRNA for the receptor only in cell types susceptible to macrophage-tropic isolates of HIV-1. See also Choe et al. (1996), who implicated both CCR5 and CCR3 in the ability of HIV-1 to infect cells expressing those receptors.

Some individuals remain uninfected by HIV-1 despite repeated exposure to the virus. Both

Liu et al. (1996) and Samson et al. (1996) identified a molecular basis for such HIV-1 resistance. Samson et al. (1996) postulated that variants of the CMKBR5 gene may be responsible for relative or absolute resistance to HIV-1 infection. In an HIV-1-infected patient with slow disease progression, Samson et al. (1996) identified a heterozygous 32-bp deletion in the CMKBR5 gene that results in a frameshift and premature termination of translation of the transcript. Liu et al. (1996) identified the same homozygous 32-bp deletion with CMKBR5 in 2 individuals who, though multiply exposed to HIV-1 infection, remained uninfected. Liu et al. (1996) found that the deletion comprises nucleotides 794 to 825 of the cDNA sequence and results in a reading frameshift after amino acid 174, inclusion of 7 novel amino acids, and truncation at codon 182. They showed that the severely truncated protein could not be detected at the surface of cells that normally express the protein. Samson et al. (1996) stated that the mutant protein lacks the last 3 of 7 putative transmembrane regions of the receptor as well as regions involved in G protein coupling and signal transduction. Through in vitro fusion assays, both Liu et al. (1996) and Samson et al. (1996) determined that the truncated receptor did not allow fusion of CD4(+) cells with cells expressing env protein from either macrophage-tropic or dual-tropic viruses. Samson et al. (1996) found that coexpression of the deletion mutant with wildtype CCR5 reduced the fusion efficiency of 2 different viral envelope proteins in 3 independent experiments.

Dean et al. (1996) reported results of their CKR5 studies in 1,955 individuals included in 6 well-characterized AIDS cohort studies. They identified 17 individuals who were homozygous for the CKR5 32-bp deletion allele (601373.0001). Deletion homozygotes occurred exclusively among the 612 members of the HIV-1-exposed, antibody-negative group and not at all in 1,343 HIV-1 infected individuals. The frequency of the CKR5 deletion heterozygotes was significantly elevated in groups of individuals who had survived HIV-1 infection for more than 10 years. In some risk groups the frequency of CKR5 deletion heterozygotes was twice as frequent as in groups with rapid progressors to AIDS. Survival analysis clearly showed that the disease progression was slower in CKR5 deletion heterozygotes than in individuals homozygous for the normal CKR5 allele. Dean et al. (1996) postulated that the CKR5 32-bp deletion may act as 'a recessive restriction gene against HIV-1 infection' and may exert a dominant phenotype of delayed progression to AIDS among infected individuals. Dean et al. (1996) reported that in addition to the CKR5 32-bp deletion allele, they found unique single-strand conformation polymorphisms (SSCPs) in other patients, some of whom were long-term nonprogressors. They speculated that at least some of these alleles disrupt CKR5 function and inhibit the spread of HIV-1 or the progression to AIDS. Dean et al. (1996) recommended that the entire coding region of CKR5 be screened in nonprogressors and in rapid progressors to identify other CKR5 variants.

To determine the role of the 32-bp deletion in CKR5 in HIV-1 transmission and disease progression, Huang et al. (1996) analyzed the CKR5 genotype of 1,252 homosexual men enrolled in the Chicago component of the Multicenter AIDS Cohort Study. No infected participant was found to be homozygous for the 32-bp deletion allele, whereas 3.6% of at-risk

but uninfected Caucasian participants were homozygous, showing the highly protective role of this genotype against sexual acquisition of HIV-1. No evidence was found that suggested heterozygotes were protected against HIV-1 infection, but a limited protective role against disease progression was noted.

Zimmerman et al. (1997) reported results of a large study that analyzed the frequency of the 32-bp deletion allele of CMKBR5 in populations from North America, Asia, and Africa. Ansari-Lari et al. (1997) also published data on the population frequencies of various mutations in CCR5. The study indicated that the mutations are relatively specific to different ethnicities, apart from the 32-bp deletion allele in the American Caucasian population, and 2 alleles in Chinese and Japanese populations, the CCR5 locus did not show a high degree of genetic variation. The authors stated that, while additional population screening at this locus might identify other sequence variants, their frequencies are likely to be less than 0.01. The frequency of the 32-bp deletion allele in American Caucasians was approximately 0.16, a value somewhat higher than that previously reported for this group.

Smith et al. (1997) analyzed 2-locus genotypes and found that the 32-bp deletion at the CCR5 locus and the 64I allele at the CCR2 locus are in strong, perhaps complete, linkage disequilibrium with each other. This means that CCR5-del32 invariably occurs on a chromosome with allele CCR2-64V, whereas CCR2-64I occurs on a chromosome that has the wildtype (undeleted) allele at the CCR5 locus. Thus, they could estimate the independent effects of the CCR2 and CCR5 polymorphisms. An estimated 38 to 45% of AIDS patients who had rapid progression of less than 3 years from HIV-1 exposure to onset of AIDS symptoms could be attributed to their wildtype status at one or the other of these loci, whereas the survival of 28 to 29% of long-term survivors, who avoided AIDS for 16 years or more, could be explained by a mutant genotype for CCR2 or CCR5.

Biti et al. (1997) reported an HIV-infected, asymptomatic individual of European descent who was found to be homozygous for the 32-bp deletion. The presence of homozygosity was supported by genotyping his sole surviving parent (a heterozygote) and his sibs (a CCR5-del32 homozygous brother, a heterozygous brother, and a CCR5 wildtype homozygous sister). The patient presented in 1992 with a seroconversion-like illness of 1-month duration, at which time he was diagnosed HIV-1 seropositive by Western blot. At the time of their report, his CD4+ T-cell count was 460, and a plasma RNA viral load test showed 19,000 copies per milliliter. Biti et al. (1997) noted that the tropism of the infecting HIV-1 strain was still under investigation.

Using a panel of monoclonal antibodies specific for human CCR5, Rottman et al. (1997) showed by immunohistochemistry and flow cytometry that CCR5 is expressed by bone marrow-derived cells known to be targets for HIV-1 infection, including a subpopulation of lymphocytes and monocytes/macrophages in blood, primary and secondary lymphoid organs, and noninflamed tissues. In the central nervous system, CCR5 was expressed on neurons, astrocytes, and microglia. In other tissues, CCR5 was expressed on epithelium, endothelium, vascular smooth muscle, and fibroblasts. Chronically inflamed tissues contained an increased

number of CCR5-positive mononuclear cells, and the number of immunoreactive cells was directly associated with a histopathologic correlate of inflammatory severity. The results suggested that CCR5-positive cells are recruited to inflammatory sites and, as such, may facilitate transmission of macrophagetropic strains of HIV-1.

Cohen et al. (1997) studied a cohort of 33 HIV-1 nonprogressors and compared 21 patients who were homozygous wildtype at the CCR5 locus with 12 who were heterozygous for the 32-bp deletion mutation in CCR5. There were no differences in CD4+ or CD8+ T-cell counts, or in plasma or lymph node viral loads. The authors concluded that CCR5 is not the sole determinant of long-term nonprogression in some HIV-1 infected individuals. Although no differences were detected at an average of 11 years postinfection, the authors suggest that CCR5 may still play a role in nonprogression by limiting viral replication during acute infection.

Although CD4 was identified initially as the cellular receptor for HIV, several lines of evidence indicated that expression of CD4 alone was insufficient to confer susceptibility to infection by the virus. Specifically, HIV did not infect mouse cells transfected with a human CD4 expression vector or mice transgenic for the expression of human CD4. Furthermore, although HIV binding and internalization can be mediated by CD4 acting together with one of several members of the chemokine receptor superfamily, CCR5 appears to be the critical coreceptor used by HIV in the initial stages of infection. However, because mouse CCR5 differs significantly from human CCR5, it cannot function as a coreceptor for HIV, and thus, expression of human CD4 alone is insufficient to permit entry of HIV into mouse cells. Browning et al. (1997) found that mice transgenic for both CD4 and CCR5 are susceptible to HIV infection.

Zagury et al. (1998) found that there were factors other than the CCR5 polymorphism accounting for the fact that exposure to HIV-1 does not usually lead to infection. Although this fact could be because of insufficient virus titer, there is abundant evidence that some individuals resist infection even when directly exposed to a high titer of HIV. This protection is related to homozygous mutations in CCR5, the receptor for the β-chemokines, and earlier studies had shown that the same chemokines markedly suppressed the nonsyncytial inducing variants of HIV-1, the chief virus type transmitted from person to person. However, CCR5 mutations are not likely to be the unique mechanism of protection because HIV-1 variants can use other chemokine receptors as their coreceptor and, indeed, infection has been demonstrated within the presence of such mutations. Zagury et al. (1998) found transient natural resistance over time of most of 128 hemophiliacs who were inoculated repeatedly with HIV-1-contaminated factor VIII concentrate from plasma during 1980 to 1985, before the development of the HIV blood test. Furthermore, and remarkably, 14 subjects remained unaffected to the time of the report, and in these subjects homozygous CCR5 mutations were found in none, but in most of them there was overproduction of β-chemokines. In vitro experiments confirmed the potent anti-HIV suppressive effect of these chemokines. The chemokines studied were generically referred to as MMR, an abbreviation for MIP-1-α, MIP-

1-β, and RANTES.

Martin et al. (1998) showed by genetic association analysis of 5 cohorts of people with AIDS that infected individuals homozygous for a multisite haplotype of the CCR5 regulatory region containing the promoter allele, CCR5P1, progress to AIDS more rapidly than those with other CCR5 promoter genotypes, particularly in the early years after infection. Composite genetic epidemiologic analyses of the genotypes bearing CCR5P1, CCR5-delta-32, CCR2-64I (see 601267), and SDF1-3-prime A (see 600835) affirmed distinct regulatory influences for each gene on AIDS progression. An estimated 10 to 17% of patients who developed AIDS within 3.5 years of HIV-1 infection did so because they were homozygous for CCR5P1/P1, and 7 to 13% of all people carry this susceptible genotype. The cumulative and interactive influence of these AIDS restriction genes illustrates the multigenic nature of host factors limiting AIDS disease progression.

CCR5 and CCR2 are tightly linked on 3p22-p21, separated by 20 kb. Common allelic variants in both genes are associated with slower progression to AIDS after infection. The protective influences of CCR5-delta-32 and CCR2-64I are independent in AIDS cohorts, and the 2 mutations have never been found on the same chromosome haplotype. The physical proximity of CCR2 and CCR5, the equivalent functional efficiency of alternative CCR2 allelic products as chemokine or HIV-1 coreceptors, and the rarity of HIV-1 strains that use the CCR2 receptor led to the speculation that CCR2-64I may be hitchhiking (or tracking by linkage disequilibrium) with an undiscovered CCR5 variant, perhaps in the cis-regulatory region, that is directly responsible for the CCR2-64I protective effect. Martin et al. (1998) found that among 2,603 individuals enrolled in 5 AIDS cohorts, CCR2-64I was always found on a CCR5P1-bearing haplotype and that CCR5-delta-32 was consistently found on a CCR5P1 haplotype as well. All CCR2-64I/64I homozygotes were always CCR5P1/P1 homozygotes (N = 43). Similarly, all CCR5-delta-32/delta-32 homozygotes were CCR5P1/P1 homozygotes (N = 18). Finally, none of 657 individuals who lacked the CCR5P1 allele had either the CCR5-delta-32 or the CCR2-64I allele. Thus the entire CCR2-CCR5 complex can be considered as a 6-allele genotype system, based on the composite CCR2 and CCR5 haplotype.

In a denaturing high-pressure liquid chromatography (DHPLC) screen of AIDS patients, Martin et al. (1998) detected 4 common allelic variants (CCR5P1-P4); 6 rare alleles (CCR5P5-P10) were discovered as heterozygotes upon subsequent single-strand conformation polymorphism (SSCP) screening of 5 AIDS cohorts. Sequence analysis of the CCR5 promoter region of individuals homozygous for the CCR5P1-P4 variants and heterozygotes of the 6 rare variants revealed 10 polymorphic nucleotide positions that described 10 CCR5 promoter haplotype alleles, referred to as promoter alleles. McDermott et al. (1998) reported a G/T variant, corresponding to position 303 of the promoter region, that showed an epidemiologic association with rapid progression to AIDS.

Farzan et al. (1999) showed that the chemokine receptor CCR5, a principal HIV-1 coreceptor, is posttranslationally modified by O-linked glycosylation and by sulfation of its N-terminal tyrosines. Sulfated tyrosines contributed to the binding of CCR5 to MIP-1-α, MIP-1-β, and

HIV-1 gp120 CD4 complexes, and to the ability of HIV-1 to enter cells expressing CCR5 and CD4. Farzan et al. (1999) concluded that tyrosine sulfation may contribute to the natural function of many 7-transmembrane-segment receptors and may be a modification common to primate immunodeficiency virus coreceptors.

Carrington et al. (1999) reviewed the growing number of genetic variants within the coding and 5-prime regulatory region of CCR5 that had been identified, several of which have functional consequences for HIV-1 pathogenesis. The findings provided logic for the development of therapeutic strategies that target the interaction of HIV-1 envelope and CCR5 in HIV-1 associated disease."

gp120

An essential component of the assay is gp120. Information on gp120 has been presented above. Further teachings on gp120 may be found in the art, such as in some of the patent applications cited above.

The nucleotide sequence encoding gp120 and the amino acid sequence for same are presented in the attached sequence listings.

CD4

In the assay of the present invention the gp120 is typically associated with CD4. A suitable CD4 is a commercialy available soluble version of CD4 (baculovirus expressed sCD4). In the preparation of the first reaction mixture, the gp120 and the CD4 may be added sequentially, simultaneously or together.

Background teachings on CD4 are mentioned above.

Background teachings on CD4 may also be found in WO-A-89/03222. The nucleotide sequence encoding same and the amino acid sequence of same is presented in the attached sequence listings.

In addition, further background teachings on CD4 have been presented by Victor A. McKusick *et al* on http://www.ncbi.nlm.nih.gov/Omim. The following further information concerning CD4 has been extracted from that source.

"Circulating mature T lymphocytes constitute a heterogeneous cell population with 2 major phenotypes, one expressing the CD4 marker on its surface (generally associated with helper-inducer function), and the other expressing the CD8 antigen (usually associated with cytotoxic-suppressor activity). Amadori et al. (1995) noted that evaluation of the CD4/CD8 ratio is routine in AIDS patients for the assessment of immune function and added that not only HIV infection but also other acute viral diseases, such as infections by cytomegalovirus, Epstein-Barr virus, and influenza virus, are usually associated with an inversion of the CD4/CD8 ratio. A low ratio is also a hallmark of intense, chronic immune responses, such as allograft rejection and graft-versus-host disease. CD4/CD8 ratios of 1.5 to 2.5 are usually considered normal. The occasional finding of a CD4/DC8 ratio less than 1 in otherwise normal, healthy individuals is usually disregarded.

Because of a personal interest on the part of one member of the group (A.A.) who had shown an invariable ratio less than 1 over many years, and because the ratio in mice was shown by Kraal et al. (1983) to be under genetic control, Amadori et al. (1995) studied the genetic pattern of inheritance of the ratio in a population of 468 healthy blood donors. Distribution of the ratio in males and females was significantly different and was significantly affected by age. In 46 randomly selected families, the parental CD4/CD8 ratios significantly influenced the ratio in offspring. Complex segregation analysis of the data rejected the non-genetic hypothesis; among the genetic models tested, a major recessive gene with a polygenic component and random environmental effects was the most parsimonious model. Overall, Amadori et al. (1995) found that 57% of the variation in the CD4/CD8 ratio could be attributed to genetic factors, as opposed to noninherited (stochastic or environmental) factors. In mice, the CD4/CD8 ratio appears to be under the genetic control of a single dominant gene (Kraal et al., 1983). Chakravarti (1995) pointed to several important implications of the simple observation in this study. First, norms for the ratio must be defined separately for different ages, genders, and perhaps even populations. The possibility of a major gene determining the ratio implies that family history of low ratios may need to be considered for accurate prognosis of HIV or other infection. The identification of genes underlying this phenotype will lead to a better understanding of the mechanisms that commit immature thymocytes to the helper or cytotoxic lineages, and the site in the developmental chain in which they function. Lastly, identification of the genes will also help answer questions regarding genetic factors that control infection and immunity.

To define the mode of inheritance of the CD4/CD8 ratio, Clementi et al. (1999) examined the absolute number of CD4 and CD8 cells in a large unselected control population and in members of 70 nuclear families. Pedigrees of nuclear families were analyzed by complex segregation analysis. Data were adjusted before this analysis to remove the effects of relevant covariates. The nongenetic transmission and the multifactorial model could be easily rejected for both CD4 and CD8 cells. The best fitting models were a major autosomal recessive gene with a residual multifactorial effect controlling the high number of CD4 and a major autosomal recessive gene with a residual multifactorial effect controlling the high number of

CD8 cells. The authors pointed out that the knowledge of the CD4+ cell number and the proportion between CD4+ and CD8+ T cells could be a useful parameter in predicting human immunodeficiency virus infection outcome."

LOW AFFINITY BINDING

As used in relation to the present invention, preferably the term "low affinity binding" means a Kd value of at least about 200 nM. More preferably the term "low affinity binding" means a Kd value of more than about 200 nM.

LIGAND

In a preferred aspect, the assay method of the present invention utilises a ligand. This ligand is capable of indicating whether said agent has modulated said interaction.

The ligand may be any suitable ligand. The ligand may be an organic chemical compound. The ligand may be a protein.

In a preferred aspect, the ligand carries a detectable label. This detectable label may become detectable once modulation has occurred – such as through a change in spectrometric properties of the ligand.

This label may be detectable by, for example, spectrometric means – such as spectrophotometric means. Preferably, however, the detectable label is a fluorescent label. Here, any suitable fluorescent can be used.

In a preferred aspect, the ligand comprises at least one antibody, preferably at least two antibodies. In this respect, the at least one antibody is termed a "first antibody". This first antibody may be able to bind to any of the agent to gp120. In a preferred aspect, the first antibody is able to bind to gp120 with high affinity and specificity, and in a mode that does not disturb the interaction of gp120 with either CD4 or CCR5.

If the ligand comprises at least two antibodies, then the at least one other antibody is called a "second antibody". The second antibody may be able to bind the first antibody. In a preferred aspect, the second antibody is able to bind to the first

antibody with high affinity and specificity, and in a way that does not disturb the interaction of the first antibody with its ligand.

Preferably, the ligand comprises the first antibody and the second antibody. In this embodiment, in the preparation of the second reaction mixture the first antibody and the second antibody may be added sequentially, simultaneously or together.

Preferably the second antibody carries the detectable label. If there is no second antibody, the first antibody typically carries the detectable label.

ANTIBODY

As indicated, preferably the ligand for use in the assay method of the present invention comprises one or two antibodies.

The "antibody" as used herein includes but is not limited to, polyclonal, monoclonal, chimeric, single chain, Fab fragments and fragments produced by a Fab expression library. Such fragments include fragments of whole antibodies which retain their binding activity for a target substance, Fv, F(ab') and F(ab')2 fragments, as well as single chain antibodies (scFv), fusion proteins and other synthetic proteins which comprise the antigen-binding site of the antibody. Furthermore, the antibodies and fragments thereof may be humanised antibodies, for example as described in US-A-239400. Neutralizing antibodies, i.e., those which inhibit biological activity of the substance polypeptides, are especially preferred for diagnostics and therapeutics.

Antibodies may be produced by standard techniques, such as by immunisation with the substance of the invention or by using a phage display library.

If polyclonal antibodies are desired, a selected mammal (e.g., mouse, rabbit, goat, horse, etc.) is immunised with an immunogenic polypeptide bearing a epitope(s) obtainable from an identified agent and/or substance of the present invention. Depending on the host species, various adjuvants may be used to increase immunological response. Such adjuvants include, but are not limited to, Freund's, mineral gels such as aluminium hydroxide, and surface active substances such as lysolecithin, pluronic polyols, polyanions, peptides, oil emulsions, keyhole limpet hemocyanin, and dinitrophenol. BCG (Bacilli Calmette-Guerin) and Corynebacterium parvum are potentially useful human adjuvants which may be employed if purified the

substance polypeptide is administered to immunologically compromised individuals for the purpose of stimulating systemic defence.

Serum from the immunised animal is collected and treated according to known procedures. If serum containing polyclonal antibodies to an epitope obtainable from an identifed agent and/or substance of the present invention contains antibodies to other antigens, the polyclonal antibodies can be purified by immunoaffinity chromatography. Techniques for producing and processing polyclonal antisera are known in the art. In order that such antibodies may be made, the invention also provides polypeptides of the invention or fragments thereof haptenised to another polypeptide for use as immunogens in animals or humans.

Monoclonal antibodies directed against particular epitopes can also be readily produced by one skilled in the art. The general methodology for making monoclonal antibodies by hybridomas is well known. Immortal antibody-producing cell lines can be created by cell fusion, and also by other techniques such as direct transformation of B lymphocytes with oncogenic DNA, or transfection with Epstein-Barr virus. Panels of monoclonal antibodies produced against orbit epitopes can be screened for various properties; i.e., for isotype and epitope affinity.

Monoclonal antibodies may be prepared using any technique which provides for the production of antibody molecules by continuous cell lines in culture. These include, but are not limited to, the hybridoma technique originally described by Koehler and Milstein (1975 Nature 256:495-497), the human B-cell hybridoma technique (Kosbor et al (1983) Immunol Today 4:72; Cote et al (1983) Proc Natl Acad Sci 80:2026-2030) and the EBV-hybridoma technique (Cole et al (1985) Monoclonal Antibodies and Cancer Therapy, Alan R Liss Inc, pp 77-96). In addition, techniques developed for the production of "chimeric antibodies", the splicing of mouse antibody genes to human antibody genes to obtain a molecule with appropriate antigen specificity and biological activity can be used (Morrison et al (1984) Proc Natl Acad Sci 81:6851-6855; Neuberger et al (1984) Nature 312:604-608; Takeda et al (1985) Nature 314:452-454). Alternatively, techniques described for the production of single chain antibodies (US Patent No. 4,946,779) can be adapted to produce the substance specific single chain antibodies.

Antibodies may also be produced by inducing in vivo production in the lymphocyte population or by screening recombinant immunoglobulin libraries or panels of highly specific binding reagents as disclosed in Orlandi et al (1989, Proc Natl Acad Sci 86: 3833-3837), and Winter G and Milstein C (1991; Nature 349:293-299).

Antibody fragments which contain specific binding sites for the substance may also be generated. For example, such fragments include, but are not limited to, the F(ab')2 fragments which can be produced by pepsin digestion of the antibody molecule and the Fab fragments which can be generated by reducing the disulfide bridges of the F(ab')2 fragments. Alternatively, Fab expression libraries may be constructed to allow rapid and easy identification of monoclonal Fab fragments with the desired specificity (Huse WD et al (1989) Science 256:1275-128 1).

ASSAY

Any one or more of appropriate targets - such as an amino acid sequence and/or nucleotide sequence - may be used for identifying an agent capable of modulating the interaction of gp120 with CCR5 in any of a variety of drug screening techniques. The target employed in such a test may be free in solution, affixed to a solid support, borne on a cell surface, or located intracellularly. The abolition of target activity or the formation of binding complexes between the target and the agent being tested may be measured.

The assay of the present invention may be a screen, whereby a number of agents are tested. In one aspect, the assay method of the present invention is a high through put screen.

Techniques for drug screening may be based on the method described in Geysen, European Patent Application 84/03564, published on September 13, 1984. In summary, large numbers of different small peptide test compounds are synthesized on a solid substrate, such as plastic pins or some other surface. The peptide test compounds are reacted with a suitable target or fragment thereof and washed. Bound entities are then detected - such as by appropriately adapting methods well known in the art. A purified target can also be coated directly onto plates for use in a drug screening techniques. Alternatively, non-neutralising antibodies can be used to capture the peptide and immobilise it on a solid support.

This invention also contemplates the use of competitive drug screening assays in which neutralising antibodies capable of binding a target specifically compete with a test compound for binding to a target.

Another technique for screening provides for high throughput screening (HTS) of agents having suitable binding affinity to the substances and is based upon the method described in detail in WO-A-84/03564.

It is expected that the assay methods of the present invention will be suitable for both small and large-scale screening of test compounds as well as in quantitative assays.

In one preferred aspect, the present invention relates to a method of identifying agents that selectively modulate the interaction between gp120 and CCR5.

In a preferred aspect, the assay of the present invention utilises cells that display CCR5 on their surface. These cells may be isolated from a subject possessing such cells. However, preferably, the cells are prepared by transfecting cells so that upon transfect those cells display on their surface CCR5. Teachings for preparing such transfected cells may be found in US-A-5939320.

REPORTERS

A wide variety of reporters may be used in the assay methods (as well as screens) of the present invention with preferred reporters providing conveniently detectable signals (eg. by spectroscopy). By way of example, a reporter gene may encode an enzyme which catalyses a reaction which alters light absorption properties.

Other protocols include enzyme-linked immunosorbent assay (ELISA), radioimmunoassay (RIA) and fluorescent activated cell sorting (FACS). A two-site, monoclonal-based immunoassay utilising monoclonal antibodies reactive to two non-interfering epitopes may even be used. These and other assays are described, among other places, in Hampton R et al (1990, Serological Methods, A Laboratory Manual, APS Press, St Paul MN) and Maddox DE et al (1983, J Exp Med 15 8:121 1).

Examples of reporter molecules include but are not limited to (galactosidase, invertase, green fluorescent protein, luciferase, chloramphenicol, acetyltransferase, (glucuronidase, exo-glucanase and glucoamylase. Alternatively, radiolabelled or fluorescent tag-labelled nucleotides can be incorporated into nascent transcripts which are then identified when bound to oligonucleotide probes.

By way of further examples, a number of companies such as Pharmacia Biotech (Piscataway, NJ), Promega (Madison, WI), and US Biochemical Corp (Cleveland, OH) supply commercial kits and protocols for assay procedures. Suitable reporter molecules or labels include those radionuclides, enzymes, fluorescent, chemiluminescent, or chromogenic agents as well as substrates, cofactors, inhibitors, magnetic particles and the like. Patents teaching the use of such labels include US-A-3817837; US-A-3850752; US-A-3939350; US-A-3996345; US-A-4277437; US-A-4275149 and US-A-4366241.

HOST CELLS

Polynucleotides for use in the present invention – such as for use as targets or for expressing targets - may be introduced into host cells.

The term "host cell" - in relation to the present invention includes any cell that could comprise the target for the agent of the present invention.

Here, polynucleotides may be introduced into prokaryotic cells or eukaryotic cells, for example yeast, insect or mammalian cells.

Polynucleotides of the invention may introduced into suitable host cells using a variety of techniques known in the art, such as transfection, transformation and electroporation. Where polynucleotides of the invention are to be administered to animals, several techniques are known in the art, for example infection with recombinant viral vectors such as retroviruses, herpes simplex viruses and adenoviruses, direct injection of nucleic acids and biolistic transformation.

Thus, a further embodiment of the present invention provides host cells transformed or transfected with a polynucleotide that is or expresses the target of the present invention. Preferably said polynucleotide is carried in a vector for the replication and

expression of polynucleotides that are to be the target or are to express the target. The cells will be chosen to be compatible with the said vector and may for example be prokaryotic (for example bacterial), fungal, yeast or plant cells.

The gram negative bacterium *E. coli* is widely used as a host for heterologous gene expression. However, large amounts of heterologous protein tend to accumulate inside the cell. Subsequent purification of the desired protein from the bulk of E.coli intracellular proteins can sometimes be difficult.

In contrast to *E.coli*, bacteria from the genus *Bacillus* are very suitable as heterologous hosts because of their capability to secrete proteins into the culture medium. Other bacteria suitable as hosts are those from the genera Streptomyces and Pseudomonas.

Depending on the nature of the polynucleotide encoding the polypeptide of the present invention, and/or the desirability for further processing of the expressed protein, eukaryotic hosts such as yeasts or other fungi may be preferred. In general, yeast cells are preferred over fungal cells because they are easier to manipulate. However, some proteins are either poorly secreted from the yeast cell, or in some cases are not processed properly (e.g. hyperglycosylation in yeast). In these instances, a different fungal host organism should be selected.

Examples of suitable expression hosts within the scope of the present invention are fungi such as Aspergillus species (such as those described in EP-A-0184438 and EP-A-0284603) and Trichoderma species; bacteria such as Bacillus species (such as those described in EP-A-0134048 and EP-A-0253455), Streptomyces species and Pseudomonas species; and yeasts such as Kluyveromyces species (such as those described in EP-A-0096430 and EP-A-0301670) and Saccharomyces species. By way of example, typical expression hosts may be selected from Aspergillus niger, Aspergillus niger var. tubigenis, Aspergillus niger var. awamori, Aspergillus aculeatis, Aspergillus nidulans, Aspergillus orvzae, Trichoderma reesei, Bacillus subtilis, Bacillus licheniformis, Bacillus amyloliquefaciens, Kluyveromyces lactis and Saccharomyces cerevisiae.

Polypeptides that are extensively modified may require correct processing to complete their function. In those instances, mammalian cell expression systems (such as HEK-293, CHO, HeLA) are required, and the polypeptides are expressed either intracellularly, on the cell membranes, or secreted in the culture media if preceded by an appropriate leader sequence.

The use of suitable host cells - such as yeast, fungal, plant and mammalian host cells - may provide for post-translational modifications (e.g. myristoylation, glycosylation, truncation, lapidation and tyrosine, serine or threonine phosphorylation) as may be needed to confer optimal biological activity on recombinant expression products of the present invention.

ORGANISM

The term "organism" in relation to the present invention includes any organism that could comprise the target according to the present invention and/or products obtained therefrom. Examples of organisms may include a fungus, yeast or a plant.

The term "transgenic organism" in relation to the present invention includes any organism that comprises the target according to the present invention and/or products obtained.

TRANSFORMATION OF HOST CELLS/HOST ORGANISMS

As indicated earlier, the host organism can be a prokaryotic or a eukaryotic organism. Examples of suitable prokaryotic hosts include *E. coli* and *Bacillus subtilis*. Teachings on the transformation of prokaryotic hosts is well documented in the art, for example see Sambrook *et al* (Molecular Cloning: A Laboratory Manual, 2nd edition, 1989, Cold Spring Harbor Laboratory Press) and Ausubel et al., Current Protocols in Molecular Biology (1995), John Wiley & Sons, Inc.

If a prokaryotic host is used then the nucleotide sequence may need to be suitably modified before transformation - such as by removal of introns.

In another embodiment the transgenic organism can be a yeast. In this regard, yeast have also been widely used as a vehicle for heterologous gene expression. The

species *Saccharomyces cerevisiae* has a long history of industrial use, including its use for heterologous gene expression. Expression of heterologous genes in *Saccharomyces cerevisiae* has been reviewed by Goodey et al (1987, Yeast Biotechnology, D R Berry et al, eds, pp 401-429, Allen and Unwin, London) and by King et al (1989, Molecular and Cell Biology of Yeasts, E F Walton and G T Yarronton, eds, pp 107-133, Blackie, Glasgow).

For several reasons *Saccharomyces cerevisiae* is well suited for heterologous gene expression. First, it is non-pathogenic to humans and it is incapable of producing certain endotoxins. Second, it has a long history of safe use following centuries of commercial exploitation for various purposes. This has led to wide public acceptability. Third, the extensive commercial use and research devoted to the organism has resulted in a wealth of knowledge about the genetics and physiology as well as large-scale fermentation characteristics of *Saccharomyces cerevisiae*.

A review of the principles of heterologous gene expression in *Saccharomyces cerevisiae* and secretion of gene products is given by E Hinchcliffe E Kenny (1993, "Yeast as a vehicle for the expression of heterologous genes", Yeasts, Vol 5, Anthony H Rose and J Stuart Harrison, eds, 2nd edition, Academic Press Ltd.).

Several types of yeast vectors are available, including integrative vectors, which require recombination with the host genome for their maintenance, and autonomously replicating plasmid vectors.

In order to prepare the transgenic Saccharomyces, expression constructs are prepared by inserting the nucleotide sequence of the present invention into a construct designed for expression in yeast. Several types of constructs used for heterologous expression have been developed. The constructs contain a promoter active in yeast fused to the nucleotide sequence of the present invention, usually a promoter of yeast origin, such as the GAL1 promoter, is used. Usually a signal sequence of yeast origin, such as the sequence encoding the SUC2 signal peptide, is used. A terminator active in yeast ends the expression system.

For the transformation of yeast several transformation protocols have been developed. For example, a transgenic Saccharomyces according to the present invention can be prepared by following the teachings of Hinnen et al (1978, Proceedings of the National Academy of Sciences of the USA 75, 1929); Beggs, J D

(1978, Nature, London, 275, 104); and Ito, H et al (1983, J Bacteriology 153, 163-168).

The transformed yeast cells are selected using various selective markers. Among the markers used for transformation are a number of auxotrophic markers such as LEU2, HIS4 and TRP1, and dominant antibiotic resistance markers such as aminoglycoside antibiotic markers, eg G418.

Another host organism is a plant. The basic principle in the construction of genetically modified plants is to insert genetic information in the plant genome so as to obtain a stable maintenance of the inserted genetic material. Several techniques exist for inserting the genetic information, the two main principles being direct introduction of the genetic information and introduction of the genetic information by use of a vector system. A review of the general techniques may be found in articles by Potrykus (Annu Rev Plant Physiol Plant Mol Biol [1991] 42:205-225) and Christou (Agro-Food-Industry Hi-Tech March/April 1994 17-27). Further teachings on plant transformation may be found in EP-A-0449375.

Further hosts suitable for the nucleotide sequence of the present invention include higher eukaryotic cells, such as insect cells or vertebrate cells, particularly mammalian cells, including human cells, or nucleated cells from other multicellular organisms. In recent years propagation of vertebrate cells in culture (tissue culture) has become a routine procedure. Examples of useful mammalian host cell lines are epithelial or fibroblastic cell lines such as Chinese hamster ovary (CHO) cells, NIH 3T3 cells, HeLa cells or 293T cells.

The nucleotide sequence of the present invention may be stably incorporated into host cells or may be transiently expressed using methods known in the art. By way of example, stably transfected mammalian cells may be prepared by transfecting cells with an expression vector having a selectable marker gene, and growing the transfected cells under conditions selective for cells expressing the marker gene. To prepare transient transfectants, mammalian cells are transfected with a reporter gene to monitor transfection efficiency.

To produce such stably or transiently transfected cells, the cells should be transfected with a sufficient amount of the nucleotide sequence of the present invention. The precise amounts of the nucleotide sequence of the present invention may be empirically determined and optimised for a particular cell and assay.

Thus, the present invention also provides a method of transforming a host cell with a nucleotide sequence that is to be the target or is to express the target. Host cells transformed with the nucleotide sequence may be cultured under conditions suitable for the expression of the encoded protein. The protein produced by a recombinant cell may be displayed on the surface of the cell. If desired, and as will be understood by those of skill in the art, expression vectors containing coding sequences can be designed with signal sequences which direct secretion of the coding sequences through a particular prokaryotic or eukaryotic cell membrane. Other recombinant constructions may join the coding sequence to nucleotide sequence encoding a polypeptide domain which will facilitate purification of soluble proteins (Kroll DJ et al (1993) DNA Cell Biol 12:441-53).

AGENT

The agent may be an organic compound or other chemical. The agent can be an amino acid sequence or a chemical derivative thereof, or a combination thereof. The agent may even be a nucleotide sequence - which may be a sense sequence or an anti-sense sequence. The agent may even be an antibody.

Typically, the agents will be organic compounds. Typically the organic compounds will comprise two or more hydrocarbyl groups. Here, the term "hydrocarbyl group" means a group comprising at least C and H and may optionally comprise one or more other suitable substituents. Examples of such substituents may include halo-, alkoxy-, nitro-, an alkyl group, a cyclic group etc. In addition to the possibility of the substituents being a cyclic group, a combination of substituents may form a cyclic group. If the hydrocarbyl group comprises more than one C then those carbons need not necessarily be linked to each other. For example, at least two of the carbons may be linked *via* a suitable element or group. Thus, the hydrocarbyl group may contain hetero atoms. Suitable hetero atoms will be apparent to those skilled in the art and include, for instance, sulphur, nitrogen and oxygen. For some applications, preferably the agent comprises at least one cyclic group,. The cyclic group may be a polycyclic group, such as a non-fused polycyclic group. For some applications, the agent comprises at least the one of said cyclic groups linked to another hydrocarbyl group.

Examples of agents may be the compounds disclosed in GB patent application No. 9922009.7 (filed 18 September 1999). The teachings of that patent application are annexed hereto (after the Sequence Listings). For ease of reference, the pages of this application (which are numbered 1 etc.) bear the Header "P60190". For the avoidance of doubt, the teachings of that application are also a part of this application.

THERAPY

The agents identified by the assay method of the present invention may be used as therapeutic agents – i.e. in therapy applications.

The term "therapy" includes curative effects, alleviation effects, and prophylactic effects.

The therapy may be on humans or animals.

If any agent(s) adversely modulate the CCR5/gp120 interaction, then those agent(s) may be useful in the treatment of anti-inflammatory diseases and conditions and in the treatment and prevention of HIV-1 and genetically related retroviral infections.

HIV

In one aspect of the present invention, the assay method is used to identify agents that could be used to treat or prevent the spread or onset of a retroviral infection, especially human immunodeficiency virus (HIV) infection – i.e. treating or preventing HIV infection – and/or as treating or preventing AIDS.

The expressions "treating or preventing AIDS", and "preventing or treating infection by HIV" as used herein are intended to mean the treatment of a wide range of states of HIV infection: AIDS, ARC (AIDS related complex), both symptomatic and asymptomatic, and actual or potential exposure to HIV. The quoted expressions are not intended, however, to be limited to the recited treatments, but rather are contemplated to include all beneficial uses relating to conditions attributable to an AIDS causative agent. For example, the identified agents may be useful in treating infection by HIV after suspected past exposure to HIV by, e.g., blood transfusion, organ transplant, exchange of body fluids, sexual intercourse, bites, needle stick, or exposure to patient blood. In addition, an identified agent may be used for the prevention of infection by HIV and the prevention of AIDS, such as in pre-or post-coital prophylaxis or in the prevention of maternal transmission of the HIV virus to a fetus or a child, whether at the time of birth, during the period of nursing, or in any other manner.

With respect to the spread of HIV infection, it has been shown that for entry into target cells, human immunodeficiency viruses require a chemokine receptor, CCR5 and CXCR-4 among others, as well as the virus's primary receptor CD4. The principal cofactor for entry mediated by the envelope glycoproteins of primary macrophage-tropic strains of HIV-1 is CCR5. Deng, et al., Nature, 381, 661-666 (1996) further discuss aspects of CCR5 mediated HIV entry.

In short, HIV attaches to the CD4 molecule on cells through a region of its envelope protein, gp120, and gp120 is part of a multi-subunit complex, most likely a trimer of gp160, i.e., gp120 + gp41. It is believed that the CD4 binding site on the gp120 of HIV interacts with the CD4 molecule on the cell surface, triggering conformational changes across the trimer, which allow it to bind to another cell-surface receptor, such as CCR5. This in turn enables gp41 to induce fusion with the cell membrane, and entry of the viral core into the cell. In addition, macrophage-tropic HIV and SIV envelope proteins have been shown to induce a signal through CCR5 on CD4+ cells, which may enhance the replication of the virus. See Weissman, et al., Nature, 389, 981-985 (1997) for a description of this phenomenon. Further, it has been shown that a complex of gp120 and soluble CD4 interacts specifically with CCR5 and inhibits the binding of the natural CCR5 ligands, as described in Wu, et al., Nature, 384, 179-183 (1996); and Trkola, et al., Nature, 384, 184-187 (1996). It has further been demonstrated that β-chemokines and related molecules, e.g., (AOP)-RANTES, prevent HIV fusion to the cell membrane and subsequent infection, both in vitro, as described in Dragic, et al., Nature, 381, 667-673 (1996), and in animal models. Finally, absence of CCR5 appears to confer protection from HIV-1 infection, as described in Nature, 382, 668-669 (1996). In particular, an inherited frame-shifting mutation in the CCR5 gene has been shown to abolish functional expression of the gene in vitro, and individuals homozygous for the mutation are apparently not susceptible to HIV infection, while at the same time they do not seem to be immuno-compromised by this variant. Furthermore, those heterozygote individuals that have been infected by HIV progress more slowly to full-blown clinical AIDS. In addition to validating the role of CCR5 in the infectious cycle of HIV, the above observations suggest that CCR5 is dispensable in the adult organism.

Although most HIV-1 isolates studied to date utilize CCR5 or CXCR-4, at least nine other chemokine receptors, or structurally related molecules, have also been described as supporting HIV-1 env-mediated membrane fusion or viral entry in vitro. These include CCR2b, CCR3, BOB/GPR15, Bonzo/STRL33/TYMSTR, GPR1,

CCR8, US28, V28/CX3CR1, LTB-4, and APJ. There is good evidence that CCR3 can be used efficiently by a significant fraction of HIV-1 isolates in vitro, provided that this protein is over-expressed in transfected cells. Nevertheless, consistent evidence indicates that anti-HIV drugs targeted to chemokine receptors may not be compromised by this variability. Indeed, the chemokines RANTES, MIP-1α, SDF-1 have been shown to suppress replication of primary HIV isolates. A derivative of RANTES, (AOP)-RANTES, is a sub-nanomolar antagonist of CCR5 function in monocytes. Monoclonal antibodies to CCR5 have been reported to block infection of cells by HIV in vitro. A small molecule antagonist of CXCR4, identified as AMD3100, has been reported to inhibit infection of susceptible cultures by CXCR4 dependent primary and lab-adapted HIV viruses while another small molecule called TAK 779 blocks entry of CCR5-tropic strains (Baba, et al. PNAS, 96 (10), 5698-5703 (1999); In addition, the majority of primary strains from early and late disease stages utilize CCR5 exclusively or in addition to other chemokine receptors, indicating that CCR5 dependent infection may play an essential role in the initiation and maintenance of productive HIV infection in a host. Accordingly, an agent which blocks or adversely modulates CCR5 in patients including mammals, and especially humans who possess normal chemokine receptors, can reasonably be expected to prevent infection in healthy individuals and slow or halt viral progression in infected patients.

ADDITIONAL BIOLOGICAL STUDIES

If desired, the agents identified by the assay method of the present invention can be further investigated using other assay systems.

By way of example, referance may be made to the CCR5 binding assay procedures disclosed in Combadiere et al., J. Leukoc. Biol. 60, 147-52 (1996); and/or intracellular calcium mobilisation assays as described by the same authors. Cell lines expressing the receptor of interest include those naturally expressing the receptor, such as PM-1, or IL-2 stimulated peripheral blood lymphocytes (PBL), or a cell engineered to express a recombinant receptor, such as CHO, 300.19, L1.2 or HEK-293. In particular, the agents may be further investigated to see if they can prevent the binding of further known chemokine ligands to CCR5 In addition, the agents may be studied further to see if they prevent intracellular calcium mobilization in response to endogenous agonists, which is consistent with their functioning as CCR5 antagonists.

Further examples of other assays include those the HIV microculture assays described in Dimitrov et al., J. Clin. Microbiol. 28, 734-737 (1990)), and the pseudotyped HIV reporter assay described in Connor et al., Virology 206 (2) 935-44 (1995). In particular, the agents can be investigated to see if they inhibit p24 production following replication of laboratory-adapted and primary HIV strains in primary blood lymphocytes (PBLs) and clonal cell-lines known to support replication of both CCR5 and CXCR-4 tropic viruses, e.g., PM-1 and MOLT4-clone 8. Furthermore, the agents can be investigated to see if they inhibit entry of chimeric HIV reporter viruses pseudotyped with envelope from a CCR5 dependent strain (ADA). Furthermore, the agents can be investigated to see if they inhibit infection of primary cells by HIV isolated from infected patient blood.

PHARMACEUTICAL COMPOSITIONS

The present invention also provides a pharmaceutical composition comprising administering a therapeutically effective amount of the agent of the present invention and a pharmaceutically acceptable carrier, diluent or excipients (including combinations thereof).

The pharmaceutical compositions may be for human or animal usage in human and veterinary medicine and will typically comprise any one or more of a pharmaceutically acceptable diluent, carrier, or excipient. Acceptable carriers or diluents for therapeutic use are well known in the pharmaceutical art, and are described, for example, in Remington's Pharmaceutical Sciences, Mack Publishing Co. (A. R. Gennaro edit. 1985). The choice of pharmaceutical carrier, excipient or diluent can be selected with regard to the intended route of administration and standard pharmaceutical practice. The pharmaceutical compositions may comprise as - or in addition to - the carrier, excipient or diluent any suitable binder(s), lubricant(s), suspending agent(s), coating agent(s), solubilising agent(s).

Preservatives, stabilizers, dyes and even flavoring agents may be provided in the pharmaceutical composition. Examples of preservatives include sodium benzoate, sorbic acid and esters of p-hydroxybenzoic acid. Antioxidants and suspending agents may be also used.

There may be different composition/formulation requirements dependent on the different delivery systems. By way of example, the pharmaceutical composition of

the present invention may be formulated to be delivered using a mini-pump or by a mucosal route, for example, as a nasal spray or aerosol for inhalation or ingestable solution, or parenterally in which the composition is formulated by an injectable form, for delivery, by, for example, an intravenous, intramuscular or subcutaneous route. Alternatively, the formulation may be designed to be delivered by both routes.

Where the agent is to be delivered mucosally through the gastrointestinal mucosa, it should be able to remain stable during transit though the gastrointestinal tract; for example, it should be resistant to proteolytic degradation, stable at acid pH and resistant to the detergent effects of bile.

Where appropriate, the pharmaceutical compositions can be administered by inhalation, in the form of a suppository or pessary, topically in the form of a lotion, solution, cream, ointment or dusting powder, by use of a skin patch, orally in the form of tablets containing excipients such as starch or lactose, or in capsules or ovules either alone or in admixture with excipients, or in the form of elixirs, solutions or suspensions containing flavouring or colouring agents, or they can be injected parenterally, for example intravenously, intramuscularly or subcutaneously. For parenteral administration, the compositions may be best used in the form of a sterile aqueous solution which may contain other substances, for example enough salts or monosaccharides to make the solution isotonic with blood. For buccal or sublingual administration the compositions may be administered in the form of tablets or lozenges which can be formulated in a conventional manner.

PHARMACEUTICAL COMBINATIONS

The agent of the present invention may be administered with one or more other pharmaceutically active substances. By way of example, the present invention covers the simultaneous, or sequential treatments with an agent according to the present invention and one or more inhibitors of HIV protease and/or inhibitors of HIV reverse transcriptase, preferably selected from the class of non-nucleoside reverse transcriptase inhibitors (NNRTI), including but not limited to nevirapine, delavirdine, and efavirenz; from among the nucleoside/nucleotide inhibitors, including but not limited to zidovudine, didanosine, zalcitabine, stavudine, lamivudine, abacavir, and adefovir dipivoxil; and from among the protease inhibitors, including but not limited to indinavir, ritonavir, saquinavir, nelfinavir, and amprenavir. Other agents useful in the above-described preferred embodiment combinations of the present invention

include current and to-be-discovered investigational drugs from any of the above classes of inhibitors, including but not limited to FTC, PMPA, fozivudine tidoxil, talviraline, S-1153, MKC-442, MSC-204, MSH-372, DMP450, PNU-140690, ABT-378, and KNI-764.

There is also included within the scope of the preferred embodiments of the present invention, combinations of an agent according to the present invention together with a supplementary therapeutic agent used for the purpose of auxiliary treatment, wherein said supplementary therapeutic agent comprises one or more members independently selected from the group consisting of proliferation inhibitors, e.g., hydroxyurea; immunomodulators, e.g., sargramostim, and various forms of interferon or interferon derivatives; fusion inhibitors, e.g., AMD3100, T-20, PRO-542, AD-349, BB-10010 and other chemokine receptor agonists/antagonists; integrase inhibitors, e.g., AR177; RNaseH inhibitors; inhibitors of viral transcription and RNA replication; and other agents that inhibit viral infection or improve the condition or outcome of HIV-infected individuals through different mechanisms.

For some applications, preferred methods of treatment of the present invention for the prevention of HIV infection, or treatment of aviremic and asymptomatic subjects potentially or effectively infected with HIV, include but are not limited to administration of a member independently selected from the group consisting of: (i) an agent according to the present invention; (ii) one NNRTI in addition to a compound of (i); (iii) two NRTI in addition to a compound of (i); (iv) one NRTI in addition to the combination of (ii); and (v) a compound selected from the class of protease inhibitors used in place of an NRTI in combinations (iii) and (iv).

For some applications, preferred methods of treatment of the present invention for the therapy of HIV-infected individuals with detectable viremia or abnormally low CD4 counts further include as a member to be selected: (vi) treatment according to (i) above in addition to the standard recommended initial regimens for the therapy of established HIV infections, e.g., as described in Bartlett, J. G., "1998 Medical management of HIV infection", Johns Hopkins University publishers, ISBN 0-9244-2809-0. Such standard regimens include but are not limited to an agent from the class of protease inhibitors in combination with two NRTIs; and (vii) a standard recommended initial regimens for the therapy of established HIV infections, e.g., as described in Bartlett, J. G., "1998 Medical management of HIV infection", Johns Hopkins University publishers, ISBN 0-9244-2809-0), where either the protease

inhibitor component, or one or both of the NRTIs is/are replaced by an agent according to the present invention.

For some applications, preferred methods of treatment of the present invention for the therapy of HIV-infected individuals that have failed antiviral therapy further include as a member to be selected: (viii) treatment according to (i) above, in addition to the standard recommended regimens for the therapy of such patients, e.g., as described in Bartlett, J. G., "1998 Medical management of HIV infection", Johns Hopkins University publishers, ISBN 0-9244-2809-0); and (ix) a standard recommended initial regimens for the therapy of patients who have failed antiretroviral therapy, e.g., as described in Bartlett, J. G., "1998 Medical management of HIV infection", Johns Hopkins University publishers, ISBN 0-9244-2809-0), where either one of the protease inhibitor components, or one or both of the NRTIs is/are replaced by an agent according to the present invention.

In the above-described combinations of the present invention, the agent of the present invention and other therapeutic active agents may be administered in terms of dosage forms either separately or in conjunction with each other, and in terms of their time of administration, either serially or simultaneously. Thus, the administration of one component agent may be prior to, concurrent with, or subsequent to the administration of the other component agent(s).

ADMINISTRATION

Typically, a physician will determine the actual dosage which will be most suitable for an individual subject and it will vary with the age, weight and response of the particular patient. The dosages below are exemplary of the average case. There can, of course, be individual instances where higher or lower dosage ranges are merited.

The compositions of the present invention may be administered by direct injection. The composition may be formulated for parenteral, mucosal, intramuscular, intravenous, subcutaneous, intraocular or transdermal administration. Depending upon the nned, the agent may be administered at a dose of from 0.01 to 30 mg/kg body weight, such as from 0.1 to 10 mg/kg, more preferably from 0.1 to 1 mg/kg body weight.

By way of further example, the agents of the present invention may be administered in accordance with a regimen of 1 to 4 times per day, preferably once or twice per day. The specific dose level and frequency of dosage for any particular patient may be varied and will depend upon a variety of factors including the activity of the specific compound employed, the metabolic stability and length of action of that compound, the age, body weight, general health, sex, diet, mode and time of administration, rate of excretion, drug combination, the severity of the particular condition, and the host undergoing therapy. In particular, however, the treatment of retroviral infections, and more particularly HIV, may be guided by genotyping and phenotyping the virus in the course of or prior to the initiation of administration of the therapeutic agent. In this way, it is possible to optimise dosing regimens and efficacy when administering an agent according to the present invention for the prevention or treatment of infection by a retrovirus, in particular, the human immunodeficiency virus (HIV).

The term "administered" includes delivery by viral or non-viral techniques. Viral delivery mechanisms include but are not limited to adenoviral vectors, adeno-associated viral (AAV) vectos, herpes viral vectors, retroviral vectors, lentiviral vectors, and baculoviral vectors. Non-viral delivery mechanisms include lipid mediated transfection, liposomes, immunoliposomes, lipofectin, cationic facial amphiphiles (CFAs) and combinations thereof. The routes for such delivery mechanisms include but are not limited to mucosal, nasal, oral, parenteral, gastrointestinal, topical, or sublingual routes.

The term "administered" includes but is not limited to delivery by a mucosal route, for example, as a nasal spray or aerosol for inhalation or as an ingestable solution; a parenteral route where delivery is by an injectable form, such as, for example, an intravenous, intramuscular or subcutaneous route.

For some applications, preferably the agent is administered orally.

GENERAL RECOMBINANT DNA METHODOLOGY TECHNIQUES

Although in general the techniques mentioned herein are well known in the art, reference may be made in particular to Sambrook et al., Molecular Cloning, A Laboratory Manual (1989) and Ausubel et al., Short Protocols in Molecular Biology (1999) 4th Ed, John Wiley & Sons, Inc. PCR is described in US-A-4683195, US-A-

4800195 and US-A-4965188.

SUMMARY

Thus, in summary, the present invention provides an assay method for determining whether an agent is capable of modulating the interaction of CCR5 with gp120. The assay method comprises incubating the agent with CCR5 and gp120 to form a first reaction mixture; and determining whether said agent modulates the interaction of CCR5 with gp120. In the method, gp120 is associated with CD4. In particular, in the assay method the interaction of CCR5 with gp120 is a low affinity binding.

The present invention also relates to agents identified using said method, as well as pharmaceutical compositions comprising same, as well as methods of therapy using same.

In a preferred embodiment the present invention provides an assay method for determining whether an agent is capable of modulating the interaction of CCR5 with gp120; the method comprising: incubating the agent with CCR5 and gp120 to form a first reaction mixture; and determining whether said agent modulates the interaction of CCR5 with gp120; wherein said gp120 is associated with CD4; wherein said interaction is a low affinity binding; and wherein said method includes the step of adding a ligand to said first reaction mixture to form a second reaction mixture; wherein said ligand is capable of indicating whether said agent has modulated said interaction; and wherein said ligand has a detectable label.

In a highly preferred embodiment the present invention provides an assay method for determining whether an agent is capable of modulating the interaction of CCR5 with gp120; the method comprising: incubating the agent with CCR5 and gp120 to form a first reaction mixture; and determining whether said agent modulates the interaction of CCR5 with gp120; wherein said gp120 is associated with CD4; wherein said interaction is a low affinity binding; and wherein said method includes the step of adding a ligand to said first reaction mixture to form a second reaction mixture; wherein said ligand is capable of indicating whether said agent has modulated said interaction; wherein said ligand has a detectable label; and wherein said ligand comprises at least a first antibody, wherein said first antibody is capable of binding to gp120 and wherein said binding is high affinity binding; and wherein said ligand possibly comprises a second antibody, wherein said second antibody is capable of

binding to said first antibody; and wherein said detectable label is associated with said second antibody, or with first antibody if second antibody is not required.

EXAMPLES

The present invention will now be described, by way of example only.

In accordance with the present invention, TR-FIA (time resolved fluorescence immunoassay) is used to determine IC50 of inhibition of gp120 binding to the receptor CCR-5 on MIP34.10 in 96 well plates.

The principle of this assay is based on competitive inhibition of gp120 binding to the receptor CCR-5 on transformed HEK-293 MIP34.10 cells. Varying concentrations of compounds and chemokines are incubated with a constant amount of the gp120, prior to addition of an anti-gp120 antibody and a secondary Eu^{3+} labelled anti-IgG. The displacement of the gp120/CD4 /antibody/antibody complex is measured by time resolved fluorescence (TRF) in a DELFIA Counter and % inhibitions are calculated using XL software.

MATERIALS AND METHODS :

Cell Culture

MIP34.10 cells supplied by Cell Biology and continued passage within the laboratory.
PBS (Dulbecco's) without Ca2+ and Mg2+ - HyQ Reagents,HyClone (cat no : B-4004-L)
1x Cell Dissociation Solution non-enzymatic - Sigma (cat no : C-5914)

Growth medium

500ml 1x Dulbecco's Modified Eagle's Medium (DMEM) with 3.7g/l sodium bicarbonate without L-glutamine - HyQ Reagents, HyClone (cat no : B-7501-L)
50ml foetal calf serum (FCS) - PAA Laboratories, Austria (cat no : A15-041)
5ml 200mM L-Glutamine - Gibco BRL (cat no : 25030-024)
5ml Penicillin/Streptomycin (100U/ml Pen/10mg/ml Strep) - Sigma (cat no : P-7539)
6.5ml 50mg/ml Geneticin - Gibco BRL (cat no : 10131-019)

162cm2 Cell Culture Flask Tissue Culture Treated - Costar (cat no : 3151)
Incubator set @ 37(C, 5% CO2 humidified

Labelling reagents

Labelling Buffer :

50mM NaHCO3 pH 8.5 - Sigma (cat no : S6014)
0.9% NaCl - Sigma (cat no : S5150)

Elution Buffer
50mM Tris-HCl pH 7.8 - Sigma (cat no : T2913)
0.9% NaCl - Sigma (cat no : S5150)
0.05% NaN3- Sigma (cat no : S8032)

Donkey anti-sheep IgG - Sigma (cat no: S2763)
Delfia Eu-labelling kit - EG&G Wallac (cat no : 1244-302)
PD-10 Sephadex G-25 pre-packed columns - Amersham Pharmacia (cat no : 17-0851-01)
UV detector and tubing
Collection tubes
Spectrophotometer

Assay Reagents

Dilution / Wash 1 / Assay Buffer :
500ml 1x Dulbecco's Modified Eagle's Medium (DMEM) with 3.7g/l sodium bicarbonate without L-glutamine - HyQ Reagents, HyClone (cat no : B-7501-L)
50ml foetal calf serum (FCS) - PAA Laboratories, Austria (cat no : A15-041)

Wash 2 Buffers
1) Wash concentrate (x25) - EG&G Wallac (cat no : 1380-0865/R)
dilute 1 25 with double distilled water

Dulbecco's PBS - Gibco BRL (cat no : 14190-094)

Enhancement
Enhancement solution - EG&G Wallac (cat no : 1244-104)

sCD4 (human recombinant T-cell) - ImmunoDiagnostics Inc (cat no : 7001)
M-Tropic BaL sgp120 produced in-house
Sheep anti-HIV-1 gp120 antibody (anti C terminal) - Aalto Bio Reagents Ltd, Ireland (cat no : D7324)
Eu3+ labelled donkey anti-sheep IgG - produced in-house as below
MIP-1 a, b or RANTES - R & D Systems (cat no : 270-LD-010, 271-BM-010 and 278-RN-010)
DMSO tissue culture grade - Sigma (cat no : D-2650)
Biocoat Cell Environments Poly-D-Lysine 96-well black/clear plates - Becton Dickinson (cat no : 6640)
Haemocytometer Counting Chamber
Multichannel Pipettes - Labsystems Finnpipette (cat no : 4510-000/020/030/040/050)
Pipette Tips - Radleys ABT Aerosol Barrier Tips (cat no : ABT-20/100/2000/1000)
Reagent Reservoirs for multichannel pipettes - Costar (cat no : 4870)
DELFIA Fluorometer (cat no : 1234-001)

Procedure

Cell Culture

MIP34.10 cells supplied by Cell Biology are cultured in 162cm2 cell culture flasks to a confluency between 50-70% in the above growth medium @ 37(C for 2-3 days in the humidified incubator.

The cells are grown at low density because of their clumpy nature and a tendency to lose their receptor at full confluency.

For cell passage, 5ml of cell dissociation solution (non-enzymatic) is added to a 1x washed (PBS) 162cm2 flask of cells, the flask rapped on the side to dislodge the cells and split according to usage, usually 1:5 or 1:10 will give sufficient cells for use within 2 -4 days.

Each 162cm2 flask used for the TR-FIA assay is washed once in 20ml PBS and 5ml cell dissociation solution (non-enzymatic) added, the flask is again rapped on the side to dislodge the cells.

The cells are placed into a 50ml centrifuge tube and 10-20ml assay buffer1 (care hould be taken not to overdilute or the cells will need to be spun down and resuspended in a smaller volume) is added into the flask to wash any residual cells out and then combined in the centrifuge tube.

The cells are gently shaken and then counted in a haemocytometer (do appropriate dilutions to enable a count).

Dilute the cells to a density of 1x106 cells/ml and plate 100mM into every well of the poly-D-Lysine plates and incubate overnight @ 37(C in the humidified incubator.

Eu^{3+} Antibody Preparation

Add 500ml of labelling buffer to the anti-sheep IgG to solubilize and transfer to the Eu-labelling reagent vial, mix thoroughly and incubate overnight at 28(C

To purify, equilibrate a PD-10 column with 3x the void volume of elution buffer, add the reaction mix and rinse the labelling vial with a small volume of elution buffer and elute.

Monitor the eluate by UV absorbance at 280nm, collect 1-2ml fractions.

Pool the protein peak fractions and measure the Eu^{3+} concentration.

Eu^{3+} Content : serially dilute above with enhancement solution from kit (1E-04 - 1E-06) and compare to the fluorescence of 1nM Eu^{3+} standard supplied in the kit.

Protein Content : calculated from the measured absorbance at 280nm after subtracting the absorbance of the formed aromatic thiourea bonds.

Calculations

Eu^{3+} mM = (Eu counts x dilution factor) / (1000 x counts of Eu standard)

Protein mg/ml = (Abs (280) - 0.008 x Eu mM) / 1.34

Protein mM = (protein mg/ml x 1000000) / 160000

Yield = Eu mM / protein mM

Recovery = 100 x protein mg/ml x volume of fraction ml / protein added mg

Compound Preparation

Solubilize 1mg compound in DMSO to a final concentration of 10mM.

2) Mix well to solubilize compound, Vortex for 10 seconds or sonibath for 2-5 minutes if necessary. Make a record of compound solubility.

Prepare a dilution series in assay buffer as necessary down at least 6 dilutions (recommended starting concn of 1(M).

Chemokines, if used. MIP-1 a, MIP-1 b and RANTES are prepared in assay buffer alone. These are sticky proteins and care must be taken on preparing these. 10(g of lyophilised material is resuspended to give a final concentration of 10(M (sonibath for 2 minutes) and dilution series prepared from this from 200nM down 6 three-fold dilutions. SP3 special tips are used for all dilutions (ABT aerosol barrier - see assay reagents above).

Assay Protocol

Add an equal mix of 36nM sCD4 (100mg/ml solution diluted 1/40 in assay buffer) and 60nM gp120 (1/120 of 1mg/ml) and incubate on ice for 15 minutes.

2) Wash the overnight plates in 100(l wash 1 buffer/well once.

Add 20(l compound or control chemokine except for the background control which is replaced with 40(l assay buffer.

Add 20(l gp120 to each background control well and add 40(l of the sCD4/gp120 complex to each well with compound and reaction control except for the background control wells.

Each mixture contains :

Reaction control : 20(l assay buffer
40(l gp120/sCD4 complex

Compound reaction : 20(l compound dilution
40(l gp120/sCD4 complex

Standard reaction : 20(l MIP-1 a, MIP-1 b or RANTES dilution
40(l gp120/sCD4 complex

Background control : 40(l binding buffer
20(l gp120

Incubate the 96 well plates @37(C on a rocking platform for 60 minutes.

Empty the plate, blot and wash with 100(l/well wash 1 buffer once.

7) Add 100(l/well of a 1/50 dilution of the sheep anti-HIV-1 gp120 antibody to each well and incubate @RT for 90 minutes with rocking.

8) Empty the plate, blot and wash with 100(l/well wash 1 buffer once.

9) Add 100(l/well of a 1/1000 dilution of the Eu3+ labelled donkey anti-sheep IgG antibody to each well and incubate @RT for 15 minutes with rocking.

10) Empty the plate, blot and wash with 100(l/well wash 2 buffer once.

Empty the plate, blot and wash with 100(l/well PBS buffer 2x.

12) Empty the plate, blot and add 200(l/well enhancement solution and vortex for 2-3 minutes.

13) The plates are read in a DELFIA 1234 Fluorometer, plates should be read between 15 and 60 minutes.

Data Analysis

All calculations are performed in Microsoft Excel or Genesis (Lab Systems version 2.12).

1) Averages and standard deviations of the replicates are computed, along with CVs.

5) An IC50 value is generated by a four point logistic sigmoid curve fit using XL software.

COMPOUNDS TESTED

Compounds of the type described above were tested in accordance with the present invention and were found to be effective in accordance with the present invention – i.e. they can modulate the interaction of CCR5 with gp120. In addition, we found that activity in the described assay correlates well with potency against HIV in microculture assays referenced above.

All publications mentioned in the above specification are herein incorporated by reference. Various modifications and variations of the described methods and system of the present invention will be apparent to those skilled in the art without departing from the scope and spirit of the present invention. Although the present invention has been described in connection with specific preferred embodiments, it should be understood that the invention as claimed should not be unduly limited to such specific embodiments. Indeed, various modifications of the described modes for carrying out the invention which are obvious to those skilled in biochemistry and biotechnology or related fields are intended to be within the scope of the following claims.

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SEQUENCE LISTINGS

CCR5

ID T90117 standard; cDNA; 1477 BP.
DE cDNA for human CCR5.
KW Human Cys-Cys chemokine receptor 5; CCR5; human immunodeficiency virus; type 1; type 2; HIV-1; HIV-2; diagnosis; treatment; prevention; inflammatory disease; rheumatoid arthritis; glomerulonephritis, asthma; idiopathic pulmonary fibrosis; psoriasis; viral infection; cancer; atherosclerosis; autoimmune disorder; ss.
OS Homo sapiens.
FH Key Location/Qualifiers
FT CDS 240..1298

SQ Sequence 1477 BP; 374 A; 349 C; 320 G; 431 T; 3 other

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gp120

Gp120 Sequences, HIV-1 BaL strain

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ANNEX NOW FOLLOWS

CLAIMS

1. An assay method for determining whether an agent is capable of modulating the interaction of CCR5 with gp120;

the method comprising:

incubating the agent with CCR5 and gp120 to form a first reaction mixture; and

determining whether said agent modulates the interaction of CCR5 with gp120;

wherein said gp120 is associated with CD4; and

wherein said interaction is a low affinity binding.

2. A method according to claim 1 wherein said method includes the step of adding a ligand to said first reaction mixture to form a second reaction mixture; wherein said ligand is capable of indicating whether said agent has modulated said interaction.

3. A method according to claim 2 wherein said ligand has a detectable label.

4. A method according to claim 3 wherein said detectable label is a fluorescent atom or a fluorescent group.

5. A method according to claim 5 wherein said radioactive atom is Eu^{3+}.

6. A method according to any one of claims 2 to 5 wherein said ligand comprises at least a first antibody.

7. A method according to claim 6 wherein said first antibody is capable of binding to gp120; and wherein said binding is high affinity binding, preferably wherein said first antibody is associated with a detectable label.

8. A method according to claim 6 or claim 7 wherein said ligand comprises at least a second antibody.

9. A method according to claim 7 wherein said second antibody is capable of binding to said first antibody.

10. A method according to claim 9 wherein said second antibody is an anti-IgG antibody.

11. A method according to any one of claims 8 to 10 when dependent on claim 3 wherein said detectable label is associated with said second antibody.

12. An agent identified by the method according to any one of claims 1 to 11, wherein said agent is capable of modulating the interaction of CCR5 with gp120.

13. A process comprising the steps of:

(a) performing the assay according to any one of claims 1 to 11;

(b) identifying one or more agents that are capable of modulating the interaction of CCR5 with gp120; and

(c) preparing a quantity of those one or more identified agents.

14. A method of affecting the *in vivo* interaction of CCR5 with gp120 with an agent;

wherein the agent is capable of modulating the interaction of CCR5 with gp120 in an *in vitro* assay method;

wherein the *in vitro* assay method is the assay method defined in any one of claims 1 to 11.

15. Use of an agent in the preparation of a pharmaceutical composition for the treatment of a disease or condition associated with the interaction of CCR5 with gp120, wherein the agent is the agent of claim 12 and/or wherein the agent is capable of modulating the interaction of CCR5 with gp120 when assayed *in vitro* by the assay method according to any one of claims 1 to 11.

16. A method of treating a subject with an agent, wherein the agent is the agent of claim 12 and/or wherein the agent is capable of modulating the interaction of CCR5 with gp120 when assayed *in vitro* by the assay method according to any one of claims 1 to 11.

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ABSTRACT

METHOD

An assay method for determining whether an agent is capable of modulating the interaction of CCR5 with gp120 is disclosed. The method comprises incubating the agent with CCR5 and gp120 to form a first reaction mixture; and determining whether said agent modulates the interaction of CCR5 with gp120; wherein said gp120 is associated with CD4. In particular, the interaction is a low affinity binding.

CCR5 MODULATORS

This invention relates to new chemical compounds. These compounds find particular but not exclusive use as pharmaceuticals, especially as CCR5 modulators.

This invention also relates to formulations or dosage forms including these compounds, to use of these compounds in manufacture of pharmaceutical formulations or dosage forms and methods of treatment, especially treatment of anti-inflammatory diseases and conditions and in the treatment and prevention of HIV-1 and genetically related retroviral infections.

The compounds of the present invention are modulators, especially antagonists, of the activity of chemokine CCR5 receptors, particularly those which occur on the surfaces of certain cells within the human body. Modulators of CCR5 receptor may be useful in the treatment and prevention of various inflammatory diseases and conditions, and in the treatment and prevention of infection by HIV-1 and genetically related retroviruses.

The name "chemokine", is a contraction of "chemotactic cytokines". The chemokines comprise a large family of proteins which have in common important structural features and which have the ability to attract leukocytes. As leukocyte chemotactic factors, chemokines play an indispensable role in the attraction of leukocytes to various tissues of the body, a process which is essential for both inflammation and the body's response to infection. Because chemokines and their receptors are central to the pathophysiology of inflammatory and infectious diseases, agents which are active in modulating, preferably antagonizing, the activity of chemokines and their receptors, are useful in the therapeutic treatment of such inflammatory and infectious diseases.

The chemokine receptor CCR5 is of particular importance in the context of treating inflammatory and infectious diseases. CCR5 is a receptor for chemokines, especially for the macrophage inflammatory proteins (MIP) designated MIP-1α and MIP-1β, and for a protein which is regulated upon activation and is normal T-cell expressed and secreted (RANTES). The relationship between modulators, especially antagonists of CCR5 activity and therapeutic usefulness in treating inflammation and HIV infection, and the manner in which such a relationship may be demonstrated, is explained in more detail further below.

There is ongoing in the art a substantial investigation of different classes of modulators of chemokine receptor activity, especially that of the CCR5 chemokine receptor. A representative disclosure is Mills *et al.* WO 98/25617 relating to substituted aryl piperazines as modulators of chemokine receptor activity. However, the compositions described therein are

not the same as, nor suggestive of those of the present invention. Further disclosures are: WO 98/025605; WO 98/025604; WO 98/002151; WO 98/004554; and WO 97/024325.

The present invention relates to compounds which may be conveniently considered to have four independently variable regions, reading from the left-hand side to right-hand side of said compound: $R_{region\ \alpha}$, $R_{region\ \beta}$, $R_{region\ \gamma}$, and $R_{region\ \delta}$, of Formula (I):

$$[R_{region\ \alpha}] - [R_{region\ \beta}] - [R_{region\ \gamma}] - [R_{region\ \delta}] \qquad (I)$$

and pharmaceutically acceptable salts and prodrug derivatives thereof. The compounds of the present invention may be selective CCR5 receptor antagonists and are non-peptidyl in structure.

The compounds as exemplified by Formula (I) may contain one or more stereogenic centers and the present invention includes the recited compounds in both their separated and their unseparated forms. The separated forms can be obtained by conventional means, *e.g.*, by asymmetric synthesis, by using high performance liquid chromatography employing a chiral stationary phase, or by chemical resolution *via* the formation of suitable salts or derivatives. It will be understood that the separate optically active forms of the compositions of the present invention, as well as racemic mixtures thereof, will usually vary with respect to their biological properties because of the chirality-dependent conformation of the active site of an enzyme, receptor, *etc.*

The description which follows provides details of the particular moieties which comprise each of said $R_{regions}$. In order to present said details in an orderly and space-saving fashion, each major group in each Region is set out with a single dash (" - "), and each successive subdivision within each said group is set out in turn with two, three, etc. dashes as required.

In this specification and claims a reference to a range or class of groups for example $(C_1\text{-}C_3)$alkyl is to be understood as an express disclosure and reference of each member of the range or class, including isomers.

According to the present invention there is provided a compound of Formula (I);

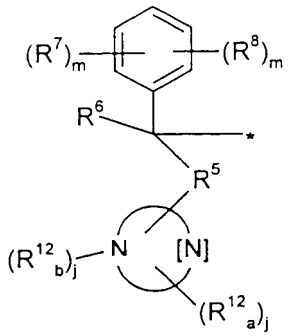
$$[R_{region\ \alpha}] - [R_{region\ \beta}] - [R_{region\ \gamma}] - [R_{region\ \delta}] \qquad (I)$$

wherein

$[R_{region\ \alpha}]$ is selected from the group consisting of:

-A. Aryl heterocyclyl substituent components comprising:

--1. hetero-phenylmethylene moieties of partial Formula (1.0.0):



(1.0.0)

---wherein: the symbol " * " indicates the point of attachment of the moiety of partial Formula (1.0.0) to R_{egion} β, as hereinafter defined;

---R^5 is a member selected from the group consisting of a direct bond; -O-; -C(=O)-; -NR^4-; and -$S(=O)_p$-; where:

----R^4 is hydrogen or (C_1 -C_2)alkyl;

---R^6 is a member selected from the group consisting of hydrogen; (C_1 -C_2)alkyl; (C_1 -C_2)alkoxy; -CN; -OH; and -$C(=O)NH_2$;

---j is an integer selected from 0, 1, and 2;

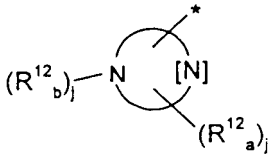
---m is an integer selected from 0, 1, and 2;

---R^7 and R^8 are each a member selected from the group consisting of -F; -Cl; -CO_2R^4; -OH; -CN; -$CONR^4_aR^4_b$; -$NR^4_aR^4_b$-; -$NR^4_aC(=O)R^4_b$; -$NR^4_aC(=O)OR^4_b$; -$NR^4_aS(=O)_pR^4_b$; -$S(=O)_pNR^4_aR^4_b$; (C_1 -C_4)alkyl, and (C_1 -C_4)alkoxy wherein said alkyl and alkoxy are each substituted with 0 to 3 substituents independently selected from F and Cl; (C_1 -C_2)alkoxycarbonyl; (C_1 -C_2)alkylcarbonyl; and (C_1 -C_2)alkylcarbonyloxy; where:

----p is an integer selected from 0, 1, and 2;

----R^4_a and R^4_b are each independently selected from hydrogen and (C_1 -C_2)alkyl;

---the moiety represented by partial Formula (1.0.1):



(1.0.1)

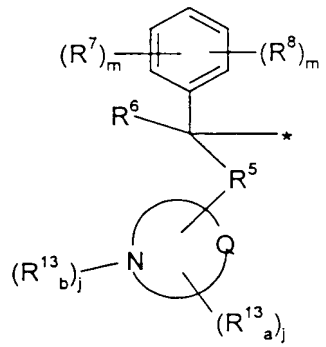
in partial Formula (1.0.0) represents a monocyclic heterocyclic group, or a bicyclic benzo-fused ring system containing said heterocyclic group wherein said heterocyclic group contains a total of 5- or 6- members of which one or two of said members is nitrogen, the presence of the optional second nitrogen atom being represented by: "[N]"; wherein said heterocyclic group or ring system are selected from the group consisting of pyrrolyl; pyrazolyl; imidazolyl; pyridinyl; pyrazinyl; pyrimidinyl; pyridazinyl; piperazinyl; indolyl; indazolinyl; benzimidazolyl; quinolinyl; *iso*-quinolinyl; and quinazolinyl; wherein:

——$R^{12}{}_a$ is a member selected from the group consisting of hydrogen; F; Cl; $-CO_2R^4$; oxo; -OH; CN; NH_2; $NH(C_1\text{-}C_2)$alkyl; $N(C_1\text{-}C_2)_2$dialkyl; $-CF_3$; $(C_1\text{-}C_4)$alkyl; $(C_2\text{-}C_4)$alkenyl; $(C_1\text{-}C_4)$alkoxy; $(C_3\text{-}C_7)$cycloalkyl; and phenyl; wherein said alkyl, alkenyl, alkoxy, cycloalkyl and phenyl are substituted with 0 to 2 substituents R^9 where:

——R^9 is a member independently selected from the group consisting of F; Cl; $-CO_2R^4$; -OH; cyano; $-CONR^4{}_aR^4{}_b$; $-NR^4{}_aR^4{}_b$-; $-NR^4{}_aC(=O)R^4{}_b$; $-NR^4{}_aC(=O)OR^4{}_b$; $-NR^4{}_aS(=O)_pR^4{}_b$; $-S(=O)_pNR^4{}_aR^4{}_b$; $(C_1\text{-}C_4)$alkyl including dimethyl, and $(C_1\text{-}C_4)$alkoxy wherein said alkyl and alkoxy are each independently substituted with 0 to 3 substituents independently selected from F and Cl; $(C_1\text{-}C_2)$alkoxycarbonyl; $(C_1\text{-}C_2)$alkylcarbonyl; and $(C_1\text{-}C_2)$alkylcarbonyloxy; and

——$R^{12}{}_b$ is absent or is a member selected from the group consisting of hydrogen; $(C_1\text{-}C_4)$alkyl; $(C_2\text{-}C_4)$alkenyl; $(C_1\text{-}C_2)$alkoxy; $(C_3\text{-}C_7)$cycloalkyl; and phenyl; wherein said alkyl, alkenyl, alkoxy, cycloalkyl and phenyl are substituted with 0 to 2 substituents R^9 wherein R^9 has the same meaning as above, except that it is selected independently selected therefrom; and

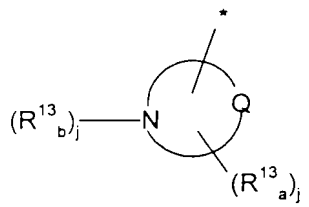
2. hetero-phenylmethylene moieties of partial Formula (1.1.0):



(1.1.0)

—wherein: the symbol " * "; R^5; R^6; R^7; R^8; j and m are as defined further above, except that all of the above-recited substituents are selected independently of their selection above;

—the moiety represented by partial Formula (1.1.1):



(1.1.1)

in partial Formula (1.1.0) represents:

----a. a monocyclic heterocyclic group containing a total of 5 or 6 members of which one said member is nitrogen and Q is selected from O and S where said S may optionally be in the sulfonate form, $-S(=O)_2$; wherein said heterocyclic group is selected from the group consisting of oxazolyl; oxazolidinyl; *iso*xazolyl; thiazolyl; thiazolidinyl; *iso*-thiazolyl; morpholinyl; and thiomorpholinyl; or

----b. a monocyclic heterocyclic group containing a total of 5- or 6- member s of which two said members are nitrogen and a third or fourth said member is independently selected from N, O, and S where said S may optionally be in the sulfonate form, $-S(=O)_2$; wherein said heterocyclic group is selected from the group consisting of triazolyl; triazinyl; tetrazolyl; oxadiazolyl; thiadiazolyl; and

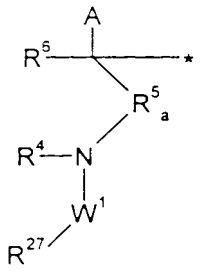
----$R^{13}{}_a$ is selected from the group consisting of hydrogen; F; Cl; $-CO_2R^4$; oxo; -OH; CN; NH_2; $NH(C_1\text{-}C_2)$alkyl; $N(C_1\text{-}C_2)_2$dialkyl; $-CF_3$; $(C_1\text{-}C_4)$alkyl; $(C_2\text{-}C_4)$alkenyl; $(C_1\text{-}C_2)$alkoxy; $(C_3\text{-}C_7)$cycloalkyl; and phenyl; wherein said alkyl, alkenyl, alkoxy, cycloalkyl and phenyl are substituted with 0 to 2 substituents R^{11} where:

-----R^{11} is a member selected from the group consisting of F; Cl; $-CO_2R^4$; -OH; -CN; $-CONR^4{}_aR^4{}_b$; $-NR^4{}_aR^4{}_b$; $-NR^4{}_aC(=O)R^4{}_b$; $-NR^4{}_aC(=O)OR^4{}_b$; $-NR^4{}_aS(=O)_pR^4{}_b$; $-S(=O)_pNR^4{}_aR^4{}_b$; $(C_1\text{-}C_4)$alkyl including dimethyl, and $(C_1\text{-}C_4)$alkoxy wherein said alkyl and alkoxy are each independently substituted with 0 to 3 substituents independently selected from F and Cl; $(C_1\text{-}C_2)$alkoxycarbonyl; $(C_1\text{-}C_2)$alkylcarbonyl; and $(C_1\text{-}C_2)$alkylcarbonyloxy; and

----$R^{13}{}_b$ is a member selected from the group consisting of hydrogen; $(C_1\text{-}C_4)$alkyl; $(C_2\text{-}C_4)$alkenyl; $(C_1\text{-}C_2)$alkoxy; $(C_3\text{-}C_7)$cycloalkyl; $C(=O)(C_1\text{-}C_4)$alkyl; $S(=O)_2(C_1\text{-}C_4)$alkyl; and phenyl; wherein said alkyl, alkenyl, alkoxy, cycloalkyl and phenyl are substituted with 0 to 2 substituents R^{11} wherein R^{11} has the same meaning as in above, except that it is selected independently;

-B. a (substituted)-amido-aryl or -heterocyclyl moiety selected from the group consisting of

--1. alkyl-, alkenyl-, and alkynyl-substituted-amido-aryl moieties of partial Formula (2.0.0):

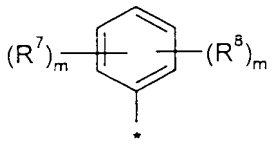


(2.0.0)

---wherein: the symbol " * "; R^4 and R^6; are as defined above, except that all of the above-recited substituents are selected independently of their selection above;

---A is a member selected from the group consisting of:

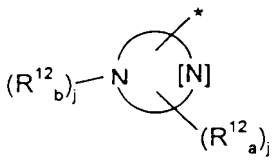
----1. the moiety of partial Formula (2.0.3)



(2.0.3)

-----wherein: the symbol R^7; R^8 and m are as defined above, except that all of the above-recited substituents are selected independently of their selection above; and the symbol: " * " indicates the point of attachment of the moiety A to the, remaining portions of partial Formula (2.0.0);

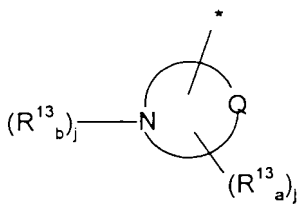
----2. the moiety of partial Formula (2.0.4)



(2.0.4)

which represents a monocyclic heterocyclic group, selected from the group consisting of pyrrolyl; pyrazolyl; imidazolyl; pyridinyl; pyrazinyl; pyrimidinyl; wherein: the symbol $R^{12}{}_a$ and $R^{12}{}_b$ are as defined above, except that all of the above-recited substituents are selected independently of their selection above; and the symbol: " * " indicates the point of attachment of the moiety A to the other, remaining portions of partial Formula (2.0.0);

----3. the moiety of partial Formula (2.0.5)



(2.0.5)

which represents

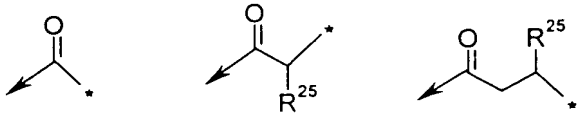
-----a. a monocyclic heteroaromatic group containing a total of 5- members of which one said member is nitrogen and Q is selected from O and S where said S may optionally be in the sulfonate form, $-S(=O)_2$; selected from the group consisting of oxazolyl; *iso*xazolyl; thiazolyl; and *iso*-thiazolyl; or

-----b. a monocyclic heterocyclic group containing a total of 5- or 6- members of which two said members are nitrogen and a third or fourth said member is independently selected from N, O, and S where said S may optionally be in the sulfonate form, $-S(=O)_2$; selected from the group consisting of triazolyl; triazinyl; tetrazolyl; oxadiazolyl; and thiadiazolyl; and

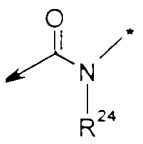
------wherein: the $R^{13}{}_a$, $R^{13}{}_b$ and j are as defined above, except that all of the above-recited substituents are selected independently of their selection above; and the symbol: " * " indicates the point of attachment of the moiety A to the other, remaining portions of partial Formula (2.0.2);

---$R^5{}_a$ is a member selected from the group consisting of a direct bond; -C(=O)-; and $-S(=O)_2$-;

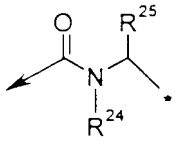
---W^1 is (1.) a direct bond; (2.) in the case where $R^5{}_a$ is -C(=O)- or $-S(=O)_2$, W^1 is a direct bond or $-(C_1\text{-}C_3)$alkylene- wherein any single carbon atom thereof is substituted by 0 to 2 substituents R^{23} where R^{23} is a member selected from the group consisting of -F; -Cl; $-CO_2R^4$; -OH; -CN; $(C_1\text{-}C_4)$alkoxy; $(C_3\text{-}C_7)$cycloalkyl; and phenyl; wherein said alkoxy, cycloalkyl, and phenyl are substituted with 0 to 2 substituents R^{11}, wherein said R^{11} is as defined above, except that all of the above-recited substituents are selected independently of their selection above; or (3.) is a member independently selected from the group consisting of the moieties of partial Formulas (2.0.6) through (2.0.16), inclusive:



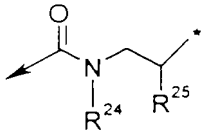
(2.0.6) (2.0.7) (2.0.8)



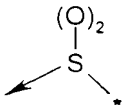
(2.0.9)



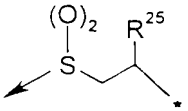
(2.0.10)



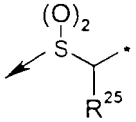
(2.0.11)



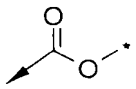
(2.0.12)



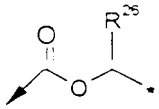
(2.0.13)



(2.0.14)



(2.0.15)



(2.0.16)

----wherein: the symbol: "→" indicates the point of attachment of the moiety W^1 to the nitrogen atom in partial Formula (2.0.0), and the symbol: " * " indicates the point of attachment of the moiety W^1 to the other, remaining portions of partial Formula (2.0.0); and R^4 is as defined further above, but selected on an independent basis;

--------R^{24} is selected from the group consisting of hydrogen and $(C_1\text{-}C_4)$alkyl; and

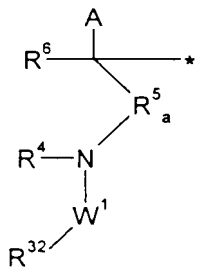
----R^{25} and R^{26} are each selected from the group consisting of -OH; $(C_1\text{-}C_2)$alkyl substituted by 0 to 3 substituents selected from F; and OH; and $(C_1\text{-}C_2)$alkoxy; and

---R^{27} is selected from the group consisting of $(C_1\text{-}C_6)$alkyl; $(C_2\text{-}C_6)$alkenyl; and $(C_2\text{-}C_6)$alkynyl; wherein said alkyl, alkenyl, and alkynyl groups comprising R^{27} are substituted with 0 to 3 substituents R^{28} where:

----R^{28} is selected from the group consisting of phenyl; F or Cl; oxo; hydroxy; $(C_1\text{-}C_2)$alkyl; $(C_1\text{-}C_3)$alkoxy; $-C(=O)OR^{29}$; $-C(=O)(C_1\text{-}C_4)$alkyl; $-S(=O)_2(C_1\text{-}C_4)$alkyl; $-C(=O)NR^{29}R^{30}$; $-NR^{29}R^{30}$; $-NR^{29}C(=O)R^{30}$; $-NR^{29}C(=O)OR^{30}$; $-NR^{29}S(=O)_pR^{30}$; and $-S(=O)_2NR^{29}R^{30}$, where:

-----R^{29} and R^{30} are each a member independently selected from the group consisting of hydrogen and $(C_1\text{-}C_4)$alkyl substituted by 0 to 3 substituents selected from the group consisting of F and Cl;

--2. cycloalkyl-substituted-amido-aryl moieties of partial Formula (2.1.0):

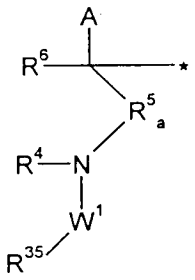


(2.1.0)

---wherein: A; W^1; the symbol " * "; R^4; $R^5{}_a$; and R^6 have the same meaning as set out above, except that all of the above-recited substituents are selected independently of their selection above; and

---R^{32} is a member selected from the group consisting of $-(CH_2)_n-(C_3\text{-}C_7)$cycloalkyl, where n is an integer selected from 0, 1, and 2; in the event n is 0, then the α-carbon atom of said $(C_3\text{-}C_7)$cycloalkyl is substituted by 0 or 1 $(C_1\text{-}C_4)$alkyl or phenyl, where said alkyl or phenyl are substituted by 0, 1, or 2 of CH_3, OCH_3, OH or NH_2; and in the event that n is 1 or 2, the resulting methylene or ethylene is substituted by 0 or 1 of F; NH_2; $N(CH_3)_2$; OH; OCH_3; $(C_1\text{-}C_4)$alkyl; or phenyl; where said alkyl and phenyl are substituted by 0, 1, or 2 of CH_3, OCH_3, OH, and NH_2; and further wherein said $(C_3\text{-}C_7)$cycloalkyl is substituted by 0 to 3 substituents R^{28} where R^{28} is as defined further above, but selected independently

--3. aryl and heterocyclic-substituted-amido-aryl moieties of partial Formula (2.2.0):



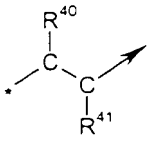
(2.2.0)

---wherein: A; W^1; the symbol: " * "; R^4; $R^5{}_a$; and R^6 have the same meaning as set out above, except that all of the above-recited substituents are selected independently of their selection above; and

---R^{35} is selected from the group consisting of phenyl; furyl; tetrahydrofuranyl; tetrahydropyranyl; oxetanyl; thienyl; pyrrolyl; pyrrolidinyl; oxazolyl; isoxazolyl; thiazolyl; isothiazolyl; imidazolyl; pyrazolyl; oxadiazolyl; thiadiazolyl; triazolyl; pyridyl; pyrazinyl; pyridazinyl; piperazinyl; pyrimidinyl; pyranyl; azetidinyl; morpholinyl; parathiazinyl; indolyl; indolinyl; benzo[*b*]furanyl; 2;3-dihydrobenzofuranyl; benzothienyl; 1H-indazolyl; benzimidazolyl; benzoxazolyl; benzisoxazolyl; benzthiazolyl; quinolinyl; isoquinolinyl; phthalazinyl; quinazolinyl; and quinoxalinyl; wherein (1.) said group R^{35} may be substituted upon any one or more carbon atoms thereof by 0 to 3 substituents R^{28} where R^{28} is as defined above, except that it is selected independently; (2.) said group R^{35} is substituted with respect to any one or more nitrogen atoms thereof that is not a point of attachment of said aryl or heterocyclic moiety, by 0 to 3 substituents $R^{13}{}_b$ where $R^{13}{}_b$ is as defined above, except that it is selected independently; and (3.) said group R^{35} with respect to any sulfur

atom thereof that is not a point of attachment of said heterocyclic moiety, is substituted by 0 or 2 oxygen atoms;

[R_{egion} β] is an alkyl bridging element of partial Formula (3.0.0):



(3.0.0)

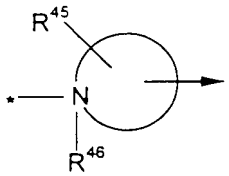
wherein:

--" * " is a symbol which represents the point of attachment of the moiety of partial Formula (3.0.0) to R_{egion} α;

--"→ " is a symbol which represents the point of attachment of the moiety of partial Formula (3.0.0) to R_{egion} γ;

--R^{40} and R^{41} are both selected from the group consisting of hydrogen; (C_1-C_2) alkyl including dimethyl; hydroxy; and (C_1-C_3) alkoxy;

[R_{egion} γ] is an aza-monocyclic moiety of partial Formula (4.0.0):



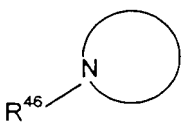
(4.0.0)

--wherein:

--" * " is a symbol which represents the point of attachment of the moiety of partial Formula (4.0.0) to R_{egion} β of the compound of Formula (I);

--"*→*" is a symbol representing a covalent bond attaching any carbon atom of said aza-monocyclic moiety of partial Formula (4.0.0) to R_{egion} δ;

--the moiety of partial Formula (4.0.1):



(4.0.1)

in partial Formula (4.0.0) represents a monocyclic heterocyclic group containing a total of from 4- to 7-members of which one said member is nitrogen, wherein said heterocyclic

group is a member independently selected from the group consisting essentially of azetidinyl; pyrrolidinyl; piperidinyl; and azepinyl;

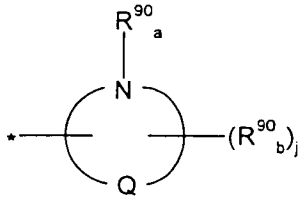
--R^{45} is absent or is a member independently selected from the group consisting essentially of (C_1-C_4)alkyl including dimethyl; (C_3-C_6)cycloalkyl; (C_1-C_4)alkoxy; (C_1-C_2)alkoxy(C1-C2)alkyl; CF_3; $-CO_2R^4$ where R^4 is as defined further above; oxo; -OH; cyano; $-C(=O)NR^4_aR^4_b$; $-NR^4_aR^4_b$; $-NR^4_aC(=O)R^4_b$; $-NR^4_aC(=O)OR^4_b$; $-NR^4_aS(=O)_pR^4_b$; $-S(=O)_pNR^4_aR^4_b$; (C_1-C_2)alkoxycarbonyl; (C_1-C_2)alkylcarbonyl; (C_1-C_2)alkylcarbonyloxy; and (C_1-C_2)alkoxy(C_1-C_2)alkyl; it being understood that in the moiety of partial Formula (4.0.0) R^{45} is a substituent attached to a single carbon atom thereof; where:

---R^4_a and R^4_b are each independently selected from hydrogen and (C_1-C_2)alkyl;

--R^{46} is absent or is a member independently selected from the group consisting essentially of hydrogen; and (C_1-C_4)alkyl substituted by 0 or 1 substituent independently selected from (C_1-C_2)alkoxy and $-CO_2R^4$ where R^4 is as defined further above; and =O; it being understood that in the case where substituent R^{46} is chosen to be other than absent, that it results in said nitrogen atom and said moiety of partial Formula (4.0.0) being in quaternary form;

[R_{egion} δ] is a (substituted)-heterocyclyl moiety selected from the group consisting of:

--1. a heterocyclyl moiety of partial Formula (5.3.0):



(5.3.0)

--wherein: the symbol: " * " indicates the point of attachment of partial Formula (5.3.0) to R_{egion} γ; Q is N, O or S and

--partial Formula (5.3.0) represents:

---a. a monocyclic heterocyclic group containing a total of 5- members of which one said member is nitrogen and a second said member is selected from O and S where said S may optionally be in the sulfonate form, wherein said heterocyclic group is selected from the group consisting of oxazolyl; *iso*xazolyl; thiazolyl; and *iso*-thiazolyl; or

----b. a monocyclic heterocyclic group containing a total of 5- members of which two said members are nitrogen and a third or fourth said member is independently selected from N, O, and S where said S may optionally be in the sulfonate form, $-S(=O)_2$; wherein said heterocyclic

group is independently selected from the group consisting of triazolyl; triazinyl; tetrazolyl; oxadiazolyl; and thiadiazolyl; and

--R^{90}_a and R^{90}_b are each a member independently selected from the group consisting of hydrogen, -(C_1-C_2)alkylcarbonyl; -(C_1-C_4)alkyl; -$(CH_2)_n$-(C_3-C_7)cycloalkyl; -(C_2-C_3)alkenyl; -$(CH_2)_n$-(phenyl); and -$(CH_2)_n$-(HET_1), where n is an integer independently selected from 0, 1, and 2; wherein said (C_1-C_4)alkyl, alkenyl, cycloalkyl, phenyl, and HET_1 groups are independently substituted with 0 to 3 substituents R^{91}, where:

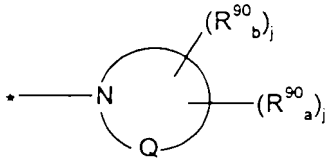
---j has the same meaning as set forth above, but is selected on an independent basis therefrom;

---HET_1 is a heterocyclyl group selected from the group consisting of thienyl; oxazolyl; isoxazolyl; thiazolyl; isothiazolyl; pyrazolyl; oxadiazolyl; thiadiazolyl; triazolyl; pyridyl; pyrazinyl; pyridazinyl; pyrimidinyl; parathiazinyl; and morpholinyl; where:

----R^{91} is selected from the group consisting of -F; -Cl; -CO_2R^4; -oxo; -OH; -CN; -$CONR^{93}R^{94}$; -$NR^{93}R^{94}$; C(=O)(C_1-C_4)alkyl; -$NR^{93}C(=O)R^{94}$; -$NR^{93}C(=O)OR^{94}$; -$NR^{93}S(=O)R^{94}$; -$S(=O)NR^{93}R^{94}$; (C_1-C_4)alkyl, and (C_1-C_4)alkoxy wherein said alkyl and alkoxy are each independently substituted with 0 to 3 substituents independently selected from F and Cl; (C_1-C_2)alkoxycarbonyl; (C_1-C_2)alkylcarbonyl; and (C_1-C_2)alkylcarbonyloxy; wherein:

-----R^{93} and R^{94} are each a member independently selected from the group consisting of hydrogen; and (C_1-C_2)alkyl; and

--2. a heterocyclyl moiety of partial Formula (5.4.0):



(5.4.0)

---wherein: R^{90}_a; R^{90}_b; and j have the same meanings as set out above, but are selected independently.

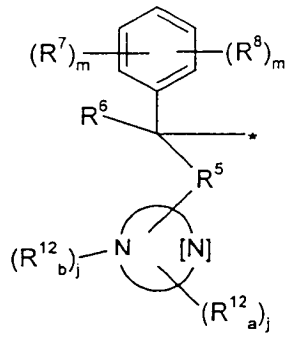
Attention is drawn to our copending applications nos P60162WO and P60191WO

An important aspect of the present invention is the limitation to R_{egion} δ. The copending cases relate to alternative limitations of Formula (I).

This invention also provides pharmaceutical formulations and dosage forms including as an active ingredient a compound of Formula I. Use of a compound of Formula I in manufacture of a formulation or dosage form and methods of treatment are also provided.

[R_{egion} α] is at the left-hand end of the CCR5 receptor modulator of the present invention. The region designated as R_{egion} α may comprise a moiety selected from several different classes of substituent components, all of which, however, are contemplated to be, and are preferably isosteres of each other.

The first class of R_{egion} α substituent components (under A.) are heterocyclyl phenylmethylene moieties as described further below. A preferred group of heterocyclyl phenylmethylene moiety embodiments (under A.1.) comprises the group consisting of hetero-phenylmethylene moieties of partial Formula (1.0.0),



(1.0.0)

The substituent R^5 is a member independently selected from the group consisting of a direct bond; -O-; -C(=O)-; -NR^4-; and-$S(=O)_p$-; where

R^4 is hydrogen or (C_1-C_2)alkyl.

The substituent R^6 is a member independently selected from the group consisting of hydrogen; (C_1-C_2)alkyl; (C_1-C_2)alkoxy; -C(=O)NH_2; -CN; and -OH. Most preferably R^6 is hydrogen and there is no substituent at this position.

Included within the partial Formula (1.0.0) are position isomer variations thereof that are not shown, but that arise where the optional substituents R^7 and R^8 are different. Substituents R^7 and R^8 are present once or twice or not at all, as indicated by their representation as: "$(R^7)_m$" and "$(R^8)_m$", where m is defined as being an integer selected from 0, 1, and 2. In the most preferred embodiments of the present invention, m is 0, although in alternative embodiments m is 1.

The substituents R^7 and R^8 comprise -F; -Cl; -CO_2R^4; -OH; -CN; -$CONR^4_aR^4_b$; -$NR^4_aR^4_b$-; -$NR^4_aC(=O)R^4_b$; -$NR^4_aC(=O)OR^4_b$; -$NR^4_aS(=O)_pR^4_b$; -$S(=O)_pNR^4_aR^4_b$; (C_1-C_4)alkyl including dimethyl, and (C_1-C_4)alkoxy wherein said alkyl and alkoxy are each independently substituted with 0 to 3 substituents independently selected from -F and -Cl; (C_1-C_2)alkoxycarbonyl; (C_1-C_2)alkylcarbonyl; and (C_1-C_2)alkylcarbonyloxy. The substituents

$R^4{}_a$ and $R^4{}_b$, in turn, are selected from hydrogen and $(C_1\text{-}C_2)$alkyl. With regard to the R^7 and R^8 substituent groups, it is preferred that they are absent (m = 0); or that if they are present, that they be methyl; cyclopropyl, cyclobutyl; methoxy; -COOH; -OH; -F; -Cl; $-COO(C_1\text{-}C_2)$alkyl; or $-CF_3$. Of these choices, the more preferred substituent choices for R^7 and R^8 are that they are absent or that they are –F or Cl.

R^5 as defined by Formula (1.0.0) is preferably a direct bond. The moiety R^5 may alternatively be selected from –O-; -C(=O)-; $-NR^4$- where R^4 is hydrogen or $(C_1\text{-}C_2)$alkyl; and $-S(=O)_p$-.

In partial Formula (1.0.0), the presence of substituent $R^{12}{}_a$ is determined by the subscript "j", which is an integer independently selected from 0, 1, and 2. Where j is 0, accordingly, the substituent $R^{12}{}_a$ will be absent. Where j is 1 or 2, there may be one or two substituents $R^{12}{}_a$ present, and these may be attached to any available carbon atom in partial Formula (1.0.0).

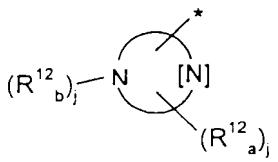
$R^{12}{}_a$ is a member independently selected from the group consisting of hydrogen; -F; -Cl; $-CO_2R^4$ where R^4 is hydrogen or $(C_1\text{-}C_2)$alkyl as already defined above; -oxo; -OH; -CN; $-NH_2$; $-NH(C_1\text{-}C_2)$alkyl; $-N(C_1\text{-}C_2)_2$dialkyl; $-CF_3$; $(C_1\text{-}C_4)$alkyl; $(C_2\text{-}C_4)$alkenyl; $(C_1\text{-}C_4)$alkoxy; $(C_3\text{-}C_7)$cycloalkyl; and phenyl; wherein said alkyl, alkenyl, alkoxy, cycloalkyl and phenyl groups are substituted with 0 to 2 substituents R^9 wherein R^9 is a member independently selected from the group consisting of -F; -Cl; $-CO_2R^4$ where R^4 is hydrogen or $(C_1\text{-}C_2)$alkyl; -OH; cyano; $-CONR^4{}_aR^4{}_b$; $-NR^4{}_aR^4{}_b$; $-NR^4{}_aC(=O)R^4{}_b$; $-NR^4{}_aC(=O)OR^4{}_b$; $-NR^4{}_aS(=O)_pR^4{}_b$; $-S(=O)_pNR^4{}_aR^4{}_b$; $(C_1\text{-}C_4)$alkyl including dimethyl, and $(C_1\text{-}C_4)$alkoxy wherein said alkyl and alkoxy are each independently substituted with 0 to 3 substituents independently selected from F and Cl; $(C_1\text{-}C_2)$alkoxycarbonyl; $(C_1\text{-}C_2)$alkylcarbonyl; and $(C_1\text{-}C_2)$alkylcarbonyloxy.

Where a $R^{12}{}_a$ substituent is present and consists of an alkyl, alkenyl, alkoxy, cycloalkyl or phenyl group, it may optionally be mono- or di-substituted in turn by a further substituent R^9, which is independently selected from the above-recited groups. This includes in particular $(C_1\text{-}C_4)$alkyl substituted with 1 to 3 substituents independently selected from F and Cl. Accordingly, the substituent $-CF_3$ is a preferred definition of R^9 in the compounds of partial Formula (1.0.0).

The $R^{12}{}_b$ substituent is attached directly to the nitrogen atom of the heterocyclic group depicted in partial Formula (1.0.0), and its presence is determined by the subscript "j", which is an integer independently selected from 0, 1, and 2. Where j is 0, accordingly, the substituent $R^{12}{}_b$ is absent. In that case that the nitrogen atom is attached by a covalent double bond to an adjacent atom in the heterocyclic group depicted in partial Formula (1.0.0). Where j is 1 or 2, there will be one or two substituents $R^{12}{}_b$ attached to the nitrogen atom of the heterocyclic group depicted in partial Formula (1.0.0). Where two such $R^{12}{}_b$ substituents are attached, the

nitrogen atom is in quaternary form. The substituent $R^{12}{}_b$ is independently selected from the group consisting of hydrogen; $(C_1\text{-}C_4)$alkyl; $(C_2\text{-}C_4)$alkenyl; $(C_1\text{-}C_2)$alkoxy; $(C_3\text{-}C_7)$cycloalkyl; and phenyl; wherein said alkyl, alkenyl, alkoxy, cycloalkyl and phenyl are substituted with 0 to 2 substituents R^9 wherein R^9 has the same meaning as in R^9 defined above, except that it is selected independently therefrom.

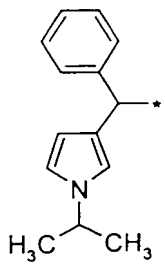
The group represented by partial Formula (1.0.1):



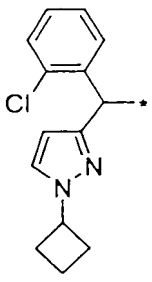
(1.0.1)

represents a monocyclic heterocyclic group, or a bicyclic benzo-fused ring system containing said heterocyclic group wherein said heterocyclic group contains a total of 5- or 6- members of which one or two of said members is nitrogen, the presence of the optional second nitrogen atom being represented by: "[N]"; wherein said heterocyclic group or ring system is selected from the group consisting of pyrrolyl; pyrazolyl; imidazolyl; pyridinyl; pyrazinyl; pyrimidinyl; pyridazinyl; piperazinyl; indolyl; indazolinyl; benzimidazolyl; quinolinyl; *iso*-quinolinyl; and quinazolinyl.

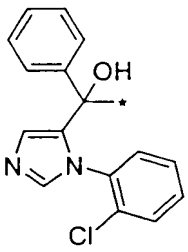
N-containing heterocyclic moieties of partial Formula (1.0.0) result in some of the following preferred embodiments of R_{egion} α, represented by partial Formulas (1.0.4) through (1.0.10), inclusive:



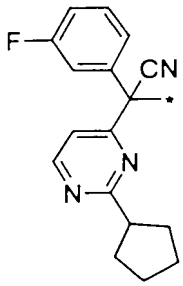
(1.0.4)



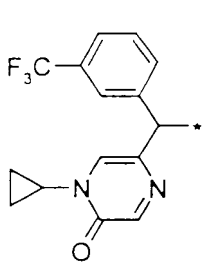
(1.0.5)



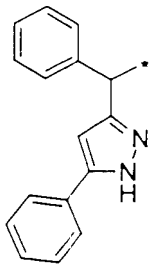
(1.0.6)



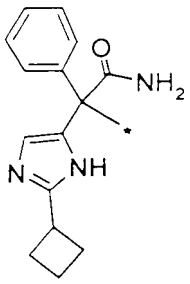
(1.0.7)



(1.0.8)

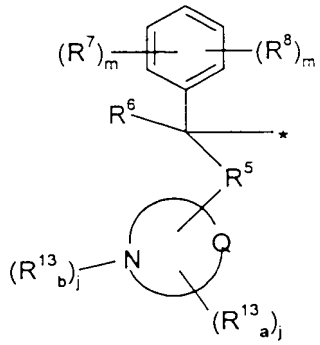


(1.0.9)



(1.0.10)

A further group of N-containing heterocyclic phenylmethylene moieties (under A.2 comprises several subgeneric groups within partial Formula (1.1.0):

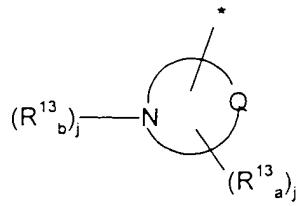


(1.1.0)

where the symbol " * " and R^5; R^6; R^7; R^8; j and m are as defined above;

and $R^{13}{}_a$ is a member selected from the group consisting of hydrogen; F; Cl; $-CO_2R^4$; oxo; -OH; CN; NH_2; $NH(C_1\text{-}C_2)$alkyl; $N(C_1\text{-}C_2)_2$dialkyl; $-CF_3$; $(C_1\text{-}C_4)$alkyl; $(C_2\text{-}C_4)$alkenyl; $(C_1\text{-}C_2)$alkoxy; $(C_3\text{-}C_7)$cycloalkyl; and phenyl; wherein said alkyl, alkenyl, alkoxy, cycloalkyl and phenyl are substituted with 0 to 2 substituents R^{11} wherein R^{11} is a member independently selected from the group consisting of F; Cl; $-CO_2R^4$; -OH; -CN; $-CONR^4{}_aR^4{}_b$; $-NR^4{}_aR^4{}_b$; $-NR^4{}_aC(=O)R^4{}_b$; $-NR^4{}_aC(=O)OR^4{}_b$; $-NR^4{}_aS(=O)_pR^4{}_b$; $-S(=O)_pNR^4{}_aR^4{}_b$; $(C_1\text{-}C_4)$alkyl including dimethyl, and $(C_1\text{-}C_4)$alkoxy wherein said alkyl and alkoxy are each independently substituted with 0 to 3 substituents independently selected from F and Cl; $(C_1\text{-}C_2)$alkoxycarbonyl; $(C_1\text{-}C_2)$alkylcarbonyl; and $(C_1\text{-}C_2)$alkylcarbonyloxy; and $R^{13}{}_b$ is selected from the group consisting of hydrogen; $(C_1\text{-}C_4)$alkyl; $(C_2\text{-}C_4)$alkenyl; $(C_1\text{-}C_2)$alkoxy; $(C_3\text{-}C_7)$cycloalkyl; $C(=O)(C_1\text{-}C_4)$alkyl; $S(=O)_2(C_1\text{-}C_4)$alkyl; and phenyl; wherein said alkyl, alkenyl, alkoxy, cycloalkyl and phenyl are substituted with 0 to 2 substituents R^{11} wherein R^{11} has the same meaning as in above, except that it is independently selected therefrom.

The moiety of partial Formula (1.1.1):

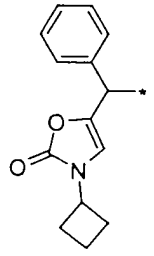


(1.1.1)

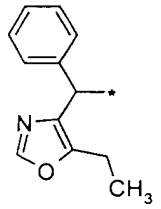
represents, *inter alia*, a monocyclic heterocyclic group containing a total of 5-members of which one said member is nitrogen and Q is selected from O and S

The heterocyclic group may be selected from the group consisting of oxazolyl; oxazolidinyl; *iso*xazolyl; thiazolyl; thiazolidinyl; *iso*-thiazolyl: morpholinyl and thiamorpholinyl.

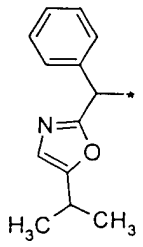
Moieties of partial Formula (1.1.0) containing the group of partial Formula (1.1.1) result in the following preferred embodiments of R_{egion} α, represented by partial Formulas (1.1.3) through (1.1.9):



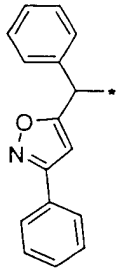
(1.1.3)



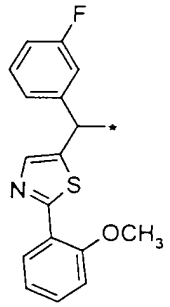
(1.1.4)



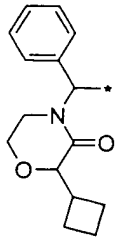
(1.1.5)



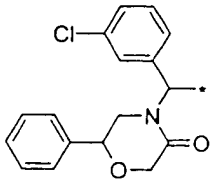
(1.1.6)



(1.1.7)



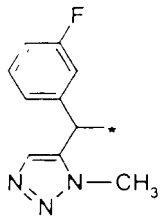
(1.1.8)



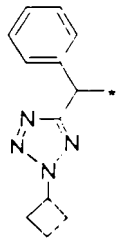
(1.1.9)

In alternative preferred embodiments the heterocyclic group may selected from the group consisting of triazolyl; triazinyl; tetrazolyl; oxadiazolyl; and thiadiazolyl.

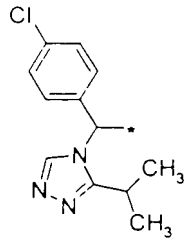
Further preferred embodiments of R_{egion} α, are represented by partial Formulas (1.1.20) through (1.1.24), inclusive:



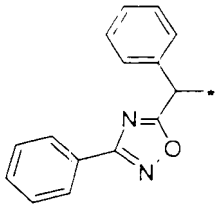
(1.1.20)



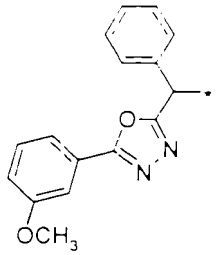
(1.1.21)



(1.1.22)



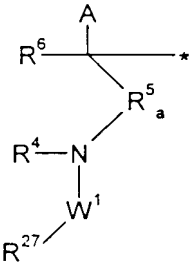
(1.1.23)



(1.1.24)

Another class of which R_{egion} α moeities (under B) are (substituted)-amido-aryl or -heterocyclyl moieties which may be independently selected from several groups, as described in more detail below.

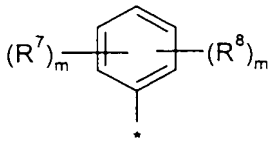
The first such class of (substituted)-amido-aryl or -heterocyclyl moieties of R_{egion} α are those in which the amido-aryl or -heterocyclyl portion of the group is substituted by alkyl-, alkenyl-, or alkynyl, as represented by partial Formula (2.0.0)



(2.0.0)

where the symbol " * " and R^4 and R^6; and m, R^7 and R^8 in the further definition of A; are as defined in the partial formulas above, except that all of the above-recited substituents are selected independently.

The moiety A in partial Formula (2.0.0) is a member independently selected from the group consisting of several different classes of moieties, as discussed below. The first class represented by partial Formula (2.0.3) is a preferred embodiment of this invention

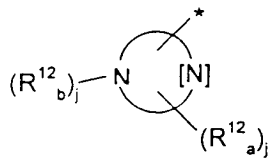


(2.0.3)

wherein the symbols R^7; R^8 and m are as defined in the partial formulas further above, except that all of the above-recited substituents are selected independently of their selection in

said partial formulas further above; and the symbol: " * " indicates the point of attachment of the moiety A to the other, remaining portions of partial Formula (2.0.0).

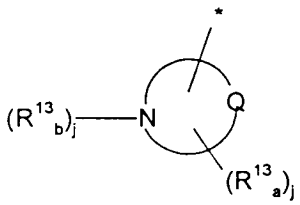
Further embodiments of moiety A are depicted by partial Formulas (2.0.4) and (2.0.5). Partial Formula (2.0.4) is:



(2.0.4)

which represents a monocyclic heterocyclic group, selected from the group consisting of pyrrolyl; pyrazolyl; imidazolyl; pyridinyl; pyrazinyl; and pyrimidinyl. It is noted that in the moiety of partial Formula (2.0.3), the symbols $R^{12}{}_a$ and $R^{12}{}_b$, and the subscript "j" which determines their presence, are as defined in the partial formulas further above, except that "j" is 0 or 1 and all of the above-recited substituents are selected independently of their selection further above; and the symbol: " * " indicates the point of attachment of the moiety A to the other, remaining portions of partial Formula (2.0.0).

Further embodiments of moiety A are depicted by partial Formula (2.0.5)



(2.0.5)

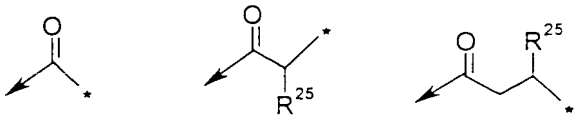
which represents a monocyclic heteroaromatic group containing a total of 5- members of which one said member is nitrogen and Q is selected from O and S where said S may optionally be in the sulfonate form, $-S(=O)_2$. Said heterocyclic group may be selected from the group consisting of oxazolyl; *iso*xazolyl; thiazolyl; and *iso*-thiazolyl; triazolyl; triazinyl; tetrazolyl; oxadiazolyl; and thiadiazolyl. It is noted that the symbols $R^{13}{}_a$ and $R^{13}{}_b$, and the subscript "j" which determines their presence, are as defined in the partial formulas further above, except that "j" is 0 or 1 and all of the above-recited substituents are selected independently of their selection in said partial formulas further above; and the symbol: " * " indicates the point of attachment of the moiety A to the other, remaining portions of partial Formula (2.0.0).

The group $R^5{}_a$ is selected from a direct bond; -C(=O)-; and $-S(=O)_2-$. In preferred embodiments of the present invention $R^5{}_a$ is a direct bond. It is provided, however, that where

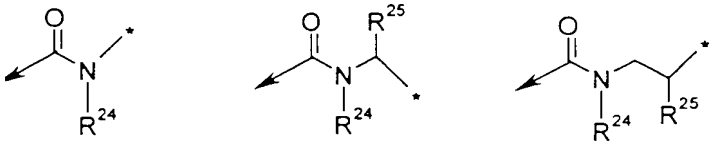
$R^5{}_a$ is –CO- or -SO_2-, the divalent moiety W^1 is defined to additionally include the meaning of being a direct bond.

In partial Formula (2.0.0), R^{27} is a member selected from the group consisting of (C_1 .C_6)alkyl; (C_2 .C_6)alkenyl; and (C_2 .C_6)alkynyl; wherein said alkyl, alkenyl, and alkynyl groups comprising R^{27} may be substituted with 0 to 3 substituents R^{28} where R^{28} is selected from the group consisting of F; Cl; oxo; hydroxy; (C_1 .C_2)alkyl; (C_1 .C_3)alkoxy; -C(=O)OR^{29}; C(=O)(C_1-C_4)alkyl; -S(=O)$_2$(C_1-C_4)alkyl; -C(=O)$NR^{29}R^{30}$; -$NR^{29}R^{30}$; -NR^{29}C(=O)R^{30}; -NR^{29}C(=O)OR^{30}; -NR^{29}S(=O)$_2R^{30}$; and -S(=O)$_2NR^{29}R^{30}$, where R^{29} and R^{30} are independently selected from hydrogen and (C_1 .C_4)alkyl.

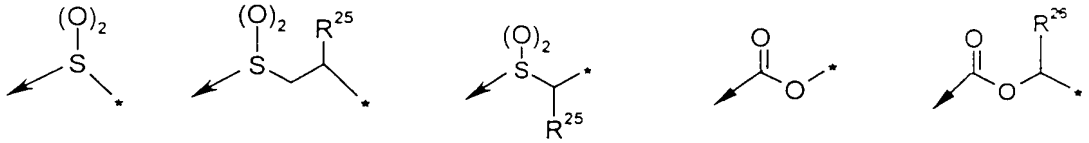
The moiety W^1 is a member independently selected from the group consisting of divalent moieties of partial Formulas (2.0.6) through (2.0.16), inclusive:



(2.0.6) (2.0.7) (2.0.8)



(2.0.19) (2.0.10) (2.0.11)

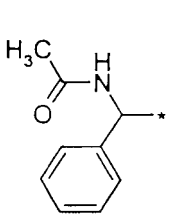


(2.0.12) (2.0.13) (2.0.14) (2.0.15) (2.0.16)

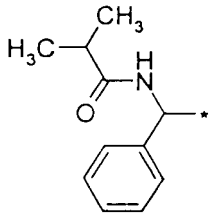
where the symbol: "→ " indicates the point of attachment of the moiety W^1 to the nitrogen atom in partial Formula (2.0.0), and the symbol: " * " indicates the point of attachment of the moiety W^1 to the moiety R^{27} which represents the remaining portions of partial Formula (2.0.0); and R^{25} and R^{26} are each independently a member selected from the group consisting of hydrogen; (C_1 .C_2)alkyl substituted by 0 or 1 substituent independently selected from F and OH; and (C_1 .C_2)alkoxy.

The bridging element -N(R^4)-W^1- may alternatively constitute or contain several different functionalities. The first and most preferred of these is an amide functionality, which may be represented as: -NR^4-C(=O)-. Other functionality types include sulfonamido and ureido moieties within the scope of partial Formulas (2.0.6) through (2.0.16).

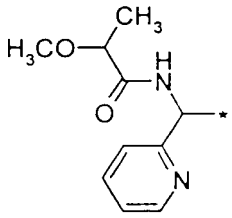
Preferred alkyl and alkenyl groups R^{27} include: methyl; ethyl; *iso*-propyl; *t*-butyl; and propenyl (allyl). These alkyl and alkenyl groups may be substituted by 0 to 3 substituents R^{28}. It is preferred that where a substituent is present that it be a single substituent independently selected from F; Cl; OH; CF_3; CH_3; OCH_3; CN; $NHCH_3$; $N(CH_3)_2$; $NHCOCH_3$; $NCH_3(COCH_3)$ and NH_2. Consequently, groups of partial Formula (2.0.0) which are preferred embodiments of the present invention constituting R_{egion} α include the following moieties of partial Formulas (2.0.30) through (2.0.36), inclusive:



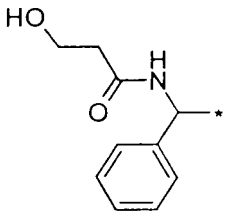
(2.0.30)



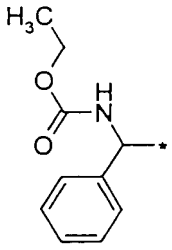
(2.0.31)



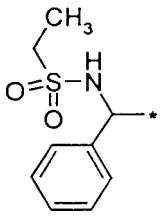
(2.0.32)



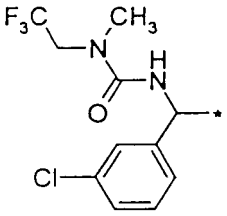
(2.0.33)



(2.0.34)

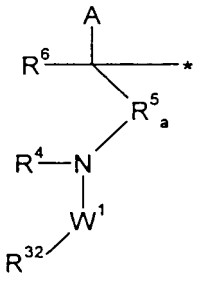


(2.0.35)



(2.0.36)

The second class of (substituted)-amido-aryl moieties comprising R_{egion} α are those in which the amido-aryl portion of the group is substituted by -(cycloalkyl) or -alkyl(cycloalkyl), as represented by partial Formula (2.1.0).

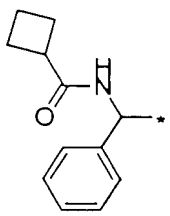


(2.1.0)

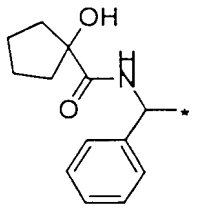
where; A; W^1; the symbol " * " and R^4; $R^5{}_a$; R^6; and m, R^7 and R^8 in the further definition of A; have the same meaning as set out in the partial formulas further above, except that all of the above-recited substituents are selected independently of their selection further

above. R^{32} is a member independently selected from the group consisting of -$-(CH_2)_n-(C_3-C_7)$cycloalkyl, where n is an integer selected from 0, 1, and 2; in the event n is 0, then the α-carbon atom of said (C_3-C_7)cycloalkyl may be substituted by (C_1-C_4)alkyl or phenyl, where said alkyl or phenyl may be substituted by 1, or 2 of CH_3, OCH_3, OH or NH_2; and in the event that n is 1 or 2, the resulting methylene or ethylene group may be substituted by of F; Cl; CN; NH_2; $N(CH_3)_2$; OH; OCH_3; (C_1-C_4)alkyl; or phenyl. It will also be further noted that the basic (C_3-C_7)cycloalkyl group comprising R^{32} may also be substituted by 0 to 3 substituents R^{28} where R^{28} has the same meaning as defined further above with respect to substituents for group R^{27} under partial Formula (2.0.0), but independently selected therefrom.

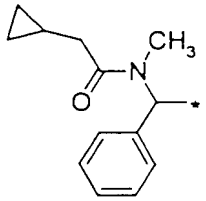
Representative cycloalkyl and alkylcycloalkyl groups within the scope of R^{32} include cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl; cyclopropylmethyl; cyclobutylethyl; cyclopentylpropmethyl; and cyclopentylmethyl. More preferred single substituents for these cycloalkyl and alkylcycloalkyl groups include F, Cl, and CN, especially OH; OCH_3; and NH_2. Accordingly, groups of partial Formula (2.1.0) which are preferred embodiments of R_{egion} α include partial Formulas (2.1.3) through (2.1.10).



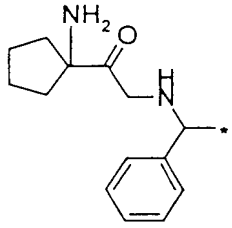
(2.1.3)



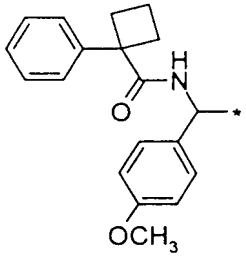
(2.1.4)



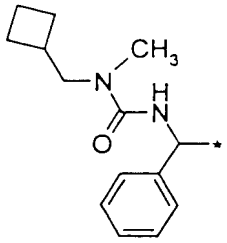
(2.1.5)



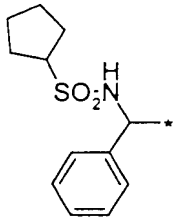
(2.1.6)



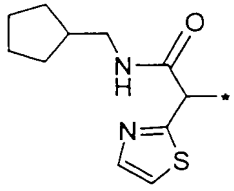
(2.1.7)



(2.1.8)

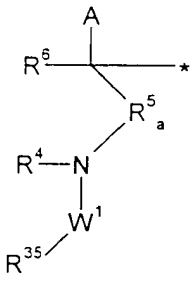


(2.1.9)



(2.1.10)

The third class of (substituted)-amido-aryl moieties of R_{egion} α are those in which the amido-aryl portion of the group is substituted by aryl- and heterocyclyl-substituted-amido-aryl moieties of partial Formula (2.2.0).



(2.2.0)

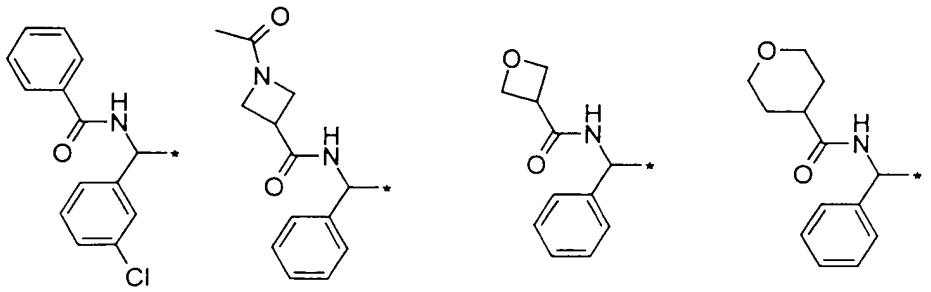
where A; W^1; the symbol " * " and R^4; R^5_a; R^6; and m, R^7 and R^8 in the definition of A; have the same meaning as set out above, except that all of the above-recited substituents are selected independently.

The moiety R^{35} may be selected from the group consisting of phenyl; furyl; tetrahydropyranyl; tetrahydrofuranyl; oxetanyl; thienyl; pyrrolyl; pyrrolidinyl; oxazolyl; isoxazolyl; thiazolyl; isothiazolyl; imidazolyl; imidazolinyl; pyrazolyl; pyrazolinyl; oxadiazolyl; thiadiazolyl; triazolyl; pyridyl; pyrazinyl; pyridazinyl; piperazinyl; pyrimidinyl; pyranyl; azetidinyl; morpholinyl; parathiazinyl; indolyl; isoindolyl; 3H-indolyl; indolinyl; benzo[*b*]furanyl; 2;3-dihydrobenzofuranyl; benzothienyl; 1H-indazolyl; benzimidazolyl; benzoxazolyl; benzisoxazolyl; benzthiazolyl; benzoxdiazolyl; quinolinyl; isoquinolinyl; phthalazinyl; quinazolinyl; and quinoxalinyl.

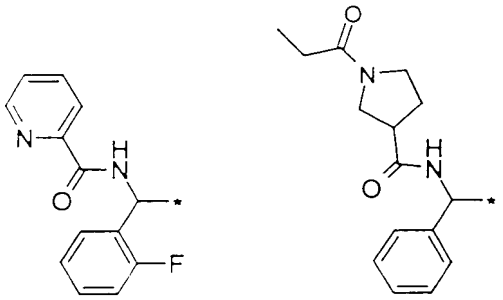
Preferred meanings of R^{35} are phenyl; pyrrolyl; oxazolyl; imidazolyl; pyridinyl; pyrimidinyl; triazolyl; indolyl; benzimidazolyl; benzotriazolyl; quinolinyl; thienyl; furfuryl; benzofuranyl; thiazolyl; oxazolyl; isoxazolyl; oxadiazolyl; and benzoxazolyl; and benzoxadiazolyl. Most preferred are tetrahydropyranyl; oxetanyl; azetidinyl and tetrahydrofuranyl. Group R^{35} may be substituted by 3 substituents R^{28} where R^{28} has the same meaning as defined above but selected independently.

Alternative aryl and heterocyclyl groups falling within the scope of R^{35} include phenyl; pyrrolyl; imidazolyl; pyridyl; oxazolyl; furyl; and benzofuranyl. Preferred single or double substituents for these groups include -CN; -F; -Cl; $-CONH_2$; $-CH_3$; $-CF_3$; and $-OCH_3$.

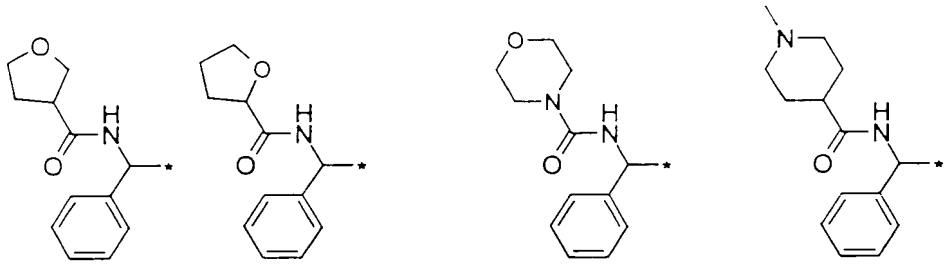
Accordingly, groups of partial Formula (2.2.0) which are preferred embodiments of R_{egion} α include partial Formulas (2.2.3) through (2.2.14)



(2.2.3) (2.2.4) (2.2.5) (2.2.6)



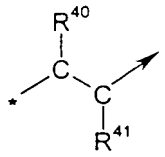
(2.2.7) (2.2.8) (2.2.9) (2.2.10)



(2.2.11) (2.2.12) (2.2.13) (2.2.14)

[R_{egion} β] comprises a bridging element between R_{egion} α described above and R_{egion} γ described below.

The alkyl bridging element of R_{egion} β comprises a moiety of partial Formula (3.0.0):

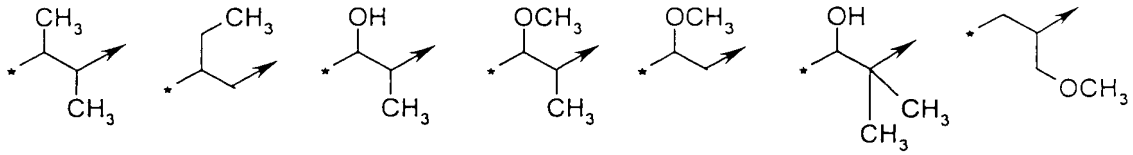


(3.0.0)

where the symbol " * " represents the point of attachment of the alkyl bridging element moiety of partial Formula (3.0.0) to R_{egion} α of the modulator compound of Formula (I); and the symbol "→" represents the point of attachment of the alkyl bridging element moiety of partial Formula (3.0.0) to R_{egion} γ of the modulator compound of Formula (I). Substituents R^{40} and R^{41} are both independently selected from the group consisting of hydrogen; (C_1-C_2) alkyl including dimethyl; hydroxy; and (C_1-C_3) alkoxy; provided that only one of R^{40} and R^{41} may be (C_1-C_3) alkoxy or hydroxy, the other one of R^{40} or R^{41} being selected from hydrogen and (C_1-C_2) alkyl including dimethyl.

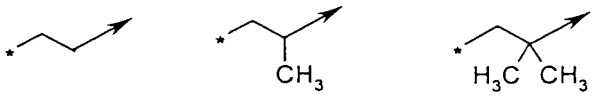
Accordingly, R^{40} and R^{41} may be hydrogen; methyl; ethyl; dimethyl, *i.e.*, two methyl groups joined to the single carbon atom to which R^{40} or R^{41} is attached; hydroxy; methoxy; ethoxy; or propoxy.

Some representative embodiments of the alkyl bridging element of partial Formula (3.0.0) include the following moieties of partial Formulas (3.0.1) through (3.0.7), inclusive:



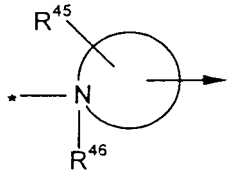
(3.0.1) (3.0.2) (3.0.3) (3.0.4) (3.0.5) (3.0.6) (3.0.7)

In the most preferred embodiments of the modulator compounds of the present invention, both R^{40} and R^{41} are hydrogen, and the alkyl bridging element of partial Formula (3.0.0) is unsubstituted ethylene. In preferred embodiments a single methyl, hydroxy, or methoxy substituent may be present, resulting in alkyl bridging elements such as those of partial Formulas (3.0.8) through (3.0.10):



(3.0.8) (3.0.9) (3.0.10)

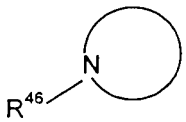
[R_{eglon} γ] comprises a member selected from the group consisting of a moiety of partial Formula (4.0.0):



(4.0.0)

where " * " is a symbol representing the point of attachment of the aza-monocyclic moiety of partial Formula (4.0.0) to R_{egion} β; and "→" is a symbol representing the point of attachment to R_{egion} δ. It will be noted that in the moieties of partial Formula (4.0.0) the nitrogen atom covalently bonds said heterocyclic moieties to R_{egion} β.

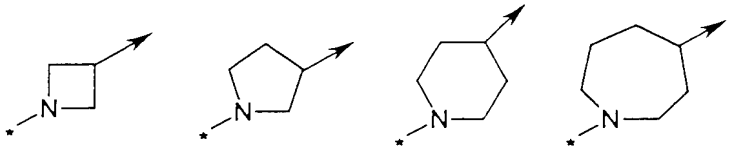
The heterocyclic moiety of partial Formula (4.0.1):



(4.0.1)

constituting a part of partial Formula (4.0.0) represents a monocyclic heterocyclic group containing a total of from 4- to 7-members of which one said member is nitrogen, wherein said heterocyclic group is a member independently selected from the group consisting essentially of azetidinyl; pyrrolidinyl; piperidinyl; and azepinyl, which may also be referred to as

homopiperidinyl. With respect to the moieties of partial Formula (4.0.0) which define $R_{region\ X}$ then, there is included the following groups represented by partial Formulas (4.0.2) through (4.0.5):

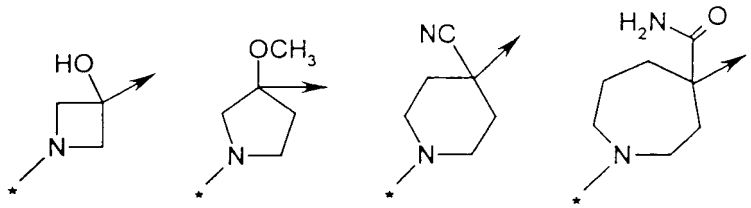


(4.0.2) (4.0.3) (4.0.4) (4.0.5)

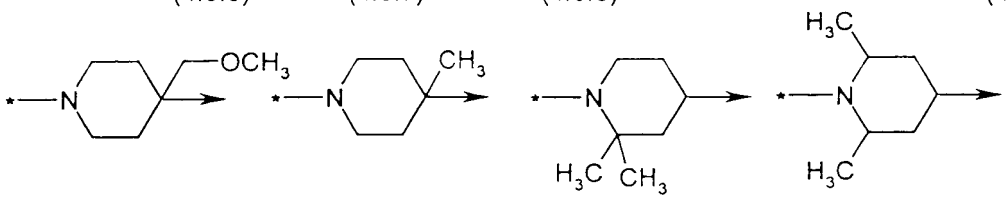
The above-defined moieties of partial Formula (4.0.0) are optionally mono-substituted by R^{45} where R^{45} is absent or is a member independently selected from the group consisting essentially of $(C_1\text{-}C_4)$alkyl including dimethyl; $(C_3\text{-}C_6)$cycloalkyl; $(C_1\text{-}C_4)$alkoxy; $(C_1\text{-}C_2)$alkoxy(C1-C2)alkyl; $-CF_3$; $-CO_2R^4$ where R^4 is as defined further above; oxo; -OH; -CN; $-C(=O)NR^4{}_aR^4{}_b$; $-NR^4{}_aR^4{}_b$; $-NR^4{}_aC(=O)R^4{}_b$; $-NR^4{}_aC(=O)OR^4{}_b$; $-NR^4{}_aS(=O)_pR^4{}_b$; $-S(=O)_pNR^4{}_aR^4{}_b$ where $R^4{}_a$ and $R^4{}_b$ are are each independently selected from hydrogen; $(C_1\text{-}C_2)$alkyl; $(C_1\text{-}C_2)$alkoxycarbonyl; $(C_1\text{-}C_2)$alkylcarbonyl; $(C_1\text{-}C_2)$alkylcarbonyloxy; and $(C_1\text{-}C_2)$alkoxy$(C_1\text{-}C_2)$alkyl. It will be understood that in the moieties of partial Formula (4.0.0), the substituent R^{45} is attached to a single carbon atom of the above-above-described heterocyclic group. It will be further understood that where R^{45} is defined as (C_1)alkyl, the methyl substituent may occur twice on a single carbon atom of the heterocyclic group, *i.e.*, be a dimethyl substituent.

The substituent group R^{46} is absent or is a member independently selected from the group consisting essentially of hydrogen; $(C_1\text{-}C_4)$alkyl substituted by 0 or 1 substituent independently selected from $(C_1\text{-}C_2)$alkoxy and $-CO_2R^4$ where R^4 is as defined further above; and $\rightarrow O$. It will be appreciated that in the case where substituent R^{46} is selected to be other than absent, that it will result in said nitrogen atom and said moiety of partial Formula (4.0.0) being in quaternary form. However, generally the quaternary forms of the compounds of the present invention are less preferred than their non-quaternary counterparts, although the skilled artisan can readily foresee that some particular embodiment may have more advantageous properties in its quaternary form than in its non-quaternary form.

Although it is preferred that the moieties of partial Formula (4.0.0) remain unsubstituted, *i.e.*, that R^{45} be absent, some examples of substituted moieties which are included within the scope of preferred embodiments of the present invention are those depicted in partial Formulas (4.0.6) through (4.0.13), inclusive:



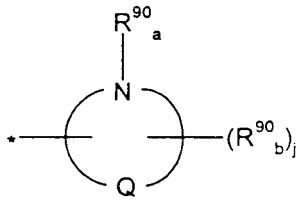
(4.0.6) (4.0.7) (4.0.8) (4.0.9)



(4.0.10) (4.0.11) (4.0.12) (4.0.13)

[R_{egion} δ] constitutes the right-hand end of the compounds of Formula (I) and is attached directly to R_{egion} γ described above. R_{egion} δ of the compounds of Formula (I) comprises two subclasses of (substituted)-heterocyclyl moieties.

The first subclass of such heterocyclyl moieties is selected from those of partial Formula (5.3.0):



(5.3.0)

where the symbol: " * " indicates the point of attachment of partial Formula (5.3.0) to R_{egion} γ; Q is N, O or S; and $R^{90}{}_a$ and $R^{90}{}_b$, , are independently selected from the group consisting of hydrogen, -(C_1 .C_2)alkylcarbonyl; -(C_1 .C_4)alkyl; -$(CH_2)_n$-(C_3 .C_7)cycloalkyl; -(C_2 .C_3)alkenyl; -$(CH_2)_n$-(phenyl); and -$(CH_2)_n$-(HET_1), where n is an integer selected from 0, 1, and 2. Further, j has the same meaning as above, but is selected independently. It is more preferred that j is 0, in which case the $R^{90}{}_b$ substituent is absent. However, preferred embodiments of the present invention also include those wherein j is 1 and $R^{90}{}_b$ is methyl.

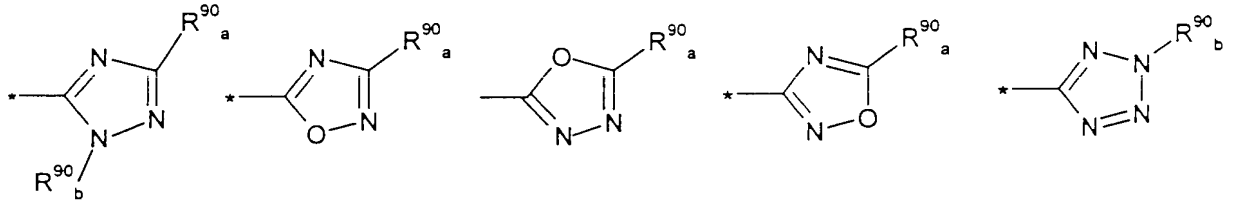
The heterocyclyl group HET_1 may be selected from the group consisting of thienyl; oxazolyl; isoxazolyl; thiazolyl; isothiazolyl; pyrazolyl; oxadiazolyl; thiadiazolyl; triazolyl; pyridyl; pyrazinyl; pyridazinyl; pyrimidinyl; parathiazinyl; morpholinyl.

The above-mentioned alkyl, alkenyl, cycloalkyl, phenyl, and heterocyclyl groups are optionally substituted with up to 3 substituents R^{91} independently selected from the group

consisting of F; Cl; -C(=O)OR^{93}; -oxo; -OH; -CN; C(=O)(C_1-C_4)alkyl; S(=O)$_2$(C_1-C_4)alkyl; -CONR^{93}R^{94}; -NR^{93}R^{94}-; -NR^{93}C(=O)R^{94}; -NR^{93}C(=O)OR^{94}; -NR^{93}S(=O)$_2$R^{94}; -S(=O)$_2$NR^{93}R^{94}; (C_1 .C_4)alkyl including dimethyl, and (C_1 .C_4)alkoxy each substituted with 1 to 3 substituents independently selected from F and Cl; (C_1 .C_2)alkoxycarbonyl; (C_1 .C_2)alkylcarbonyl; and (C_1 .C_2)alkylcarbonyloxy, where R^{93} and R^{94} are each a member independently selected from the group consisting of hydrogen; and (C_1 .C_2)alkyl.

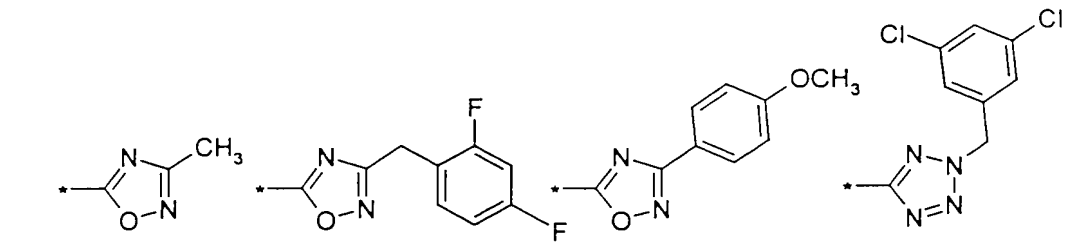
The heterocyclyic group which constitutes a part of the moiety of partial Formula (5.3.0), may be a five membered monocyclic group containing two or more of N, O or S, for example oxazolyl; *iso*xazolyl; thiazolyl; *iso*-thiazolyl; triazolyl; triazinyl; tetrazolyl; oxadiazolyl; and thiadiazolyl.

Preferred embodiments include Formulas (5.3.5) through (5.3.9):

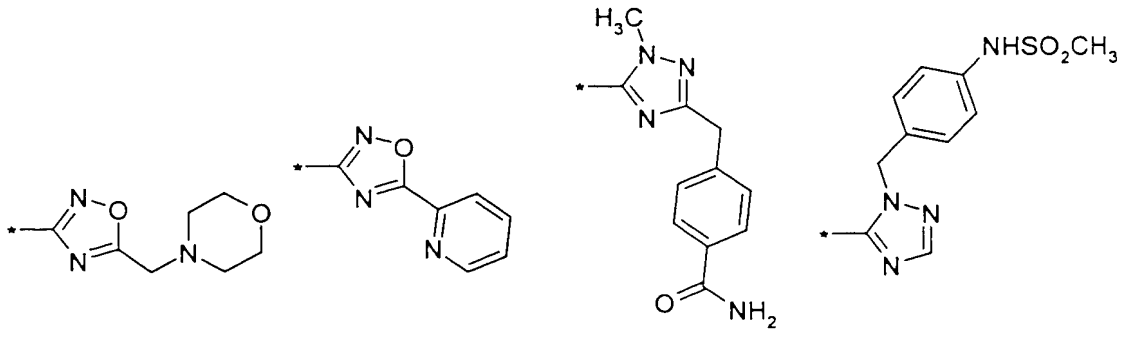


(5.3.5) (5.3.6) (5.3.7) (5.3.8) (5.3.9)

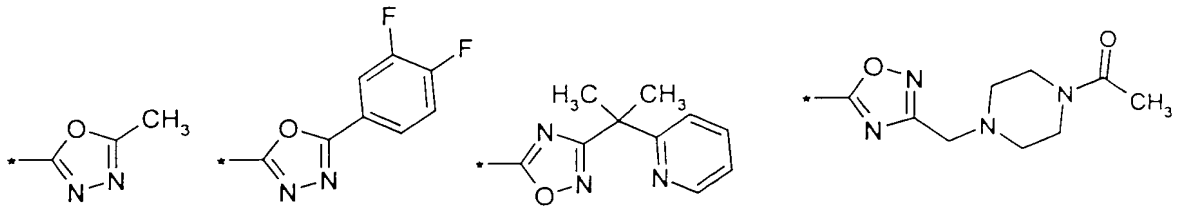
Accordingly, the following are preferred embodiments of the compounds of the present invention comprising moieties defining R_{egion} δ in accordance with partial Formula (5.3.0), as represented by partial Formulas (5.3.15) through (5.3.26):



(5.3.15) (5.3.16) (5.3.17) (5.3.18)

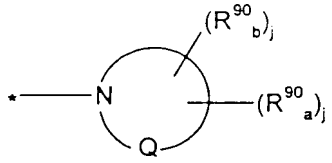


(5.3.19) (5.3.20) (5.3.21) (5.3.22)



(5.3.23) (5.3.24) (5.3.25) (5.3.26)

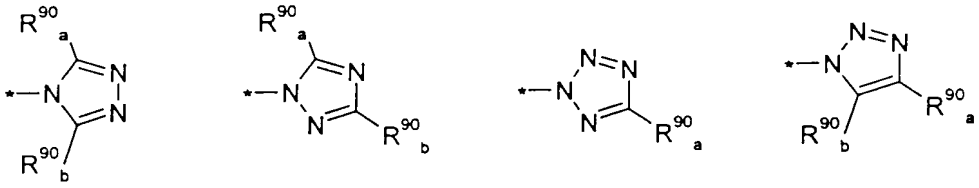
The second subclass of moieties (under C.2.) defining R_{egion} δ may be selected from those of partial Formula (5.4.0):



(5.4.0)

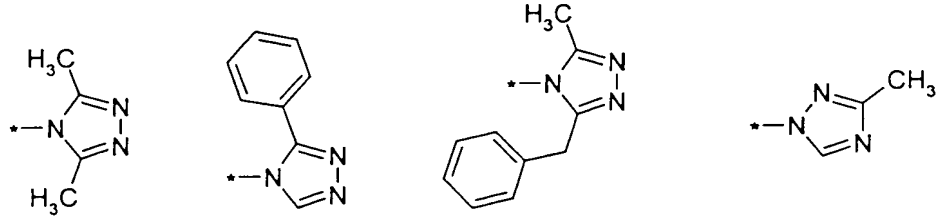
where Q, $R^{90}{}_a$ and $R^{90}{}_b$ have the same meaning as defined above, but are selected independently.

The heterocyclic group may be the same as in Formula 5.3.0 except that the nitrogen atom is the point of attachment. Accordingly, Formulas (5.4.5) through (5.4.8) result:

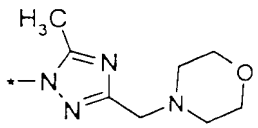


(5.4.5) (5.4.6) (5.4.7) (5.4.8)

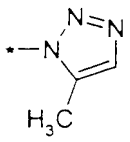
The following preferred embodiments of R_{egion} δ are represented by partial Formulas (5.4.10) through (5.4.17):



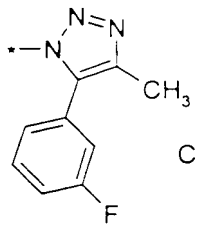
(5.4.10) (5.4.11) (5.4.12) (5.4.13)



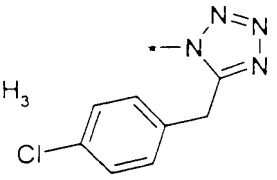
(5.4.14)



(5.4.15)



(5.4.16)



(5.4.17)

The compounds of the present invention may be utilized in the form of acids, esters, or other chemical derivatives. It is also within the scope of the present invention to utilize those compounds in the form of pharmaceutically acceptable salts derived from various organic and inorganic acids and bases in accordance with procedures well known in the art. The expression "pharmaceutically acceptable salt" as used herein is intended to mean an active ingredient comprising a compound of Formula (I) utilized in the form of a salt thereof, especially where said salt form confers on said active ingredient improved pharmacokinetic properties as compared to the free form of said active ingredient or other previously disclosed salt form.

A pharmaceutically acceptable salt form of said active ingredient may also initially confer a desirable pharmacokinetic property on said active ingredient which it did not previously possess, and may even positively affect the pharmacodynamics of said active ingredient with respect to its therapeutic activity in the body.

The pharmacokinetic properties of said active ingredient which may be favorably affected include, *e.g.*, the manner in which said active ingredient is transported across cell membranes, which in turn may directly and positively affect the absorption, distribution, biotransformation or excretion of said active ingredient. While the route of administration of the pharmaceutical composition is important and various anatomical, physiological and pathological factors can critically affect bioavailability, the solubility of said active ingredient is usually dependent upon the character of the particular salt form thereof which it utilized. Further, an aqueous solution may provide the most rapid absorption of an active ingredient into the body of a patient being treated, while lipid solutions and suspensions, as well as solid dosage forms, may result in less rapid absorption. Oral ingestion of said active ingredient is the most preferred route of administration for reasons of safety, convenience, and economy, but absorption of such an oral dosage form can be adversely affected by physical characteristics such as polarity, emesis caused by irritation of the gastrointestinal mucosa, destruction by digestive enzymes and low pH, irregular absorption or propulsion in the presence of food or other drugs, and metabolism by enzymes of the mucosa, the intestinal flora, or the liver. Formulation of said active ingredient into different pharmaceutically

acceptable salt forms may be effective in overcoming or alleviating one or more of the above-recited problems encountered with absorption of oral dosage forms.

Well-known pharmaceutically acceptable salts include, but are not limited to acetate, adipate, alginate, aspartate, benzoate, benzenesulfonate, besylate, bisulfate, butyrate, citrate, camphorate, camphorsulfonate, cyclopentanepropionate, digluconate, dodecysulfate, ethanesulfonate, fumarate, glucoheptanoate, gluconate, glycerophosphate, hemisuccinate, hemisulfate, heptanoate, hexanoate, hippurate, hydrochloride, hydrobromide, hydroiodide, 2-hydroxyethanesulfonate, isethionate, lactate, lactobionate, maleate, mandelate, methanesulfonate, 2-naphthalenesulfonate, nicotinate, nitrate, oxalate, oleate, pamoate, pectinate, persulfate, 3-phenylpropionate, phosphonate, picrate, pivalate, propionate, salicylate, sodium phosphate, stearate, succinate, sulfate, sulfosalicylate, tartrate, thiocyanate, thiomalate, tosylate, and undecanoate.

Base salts of the compounds of the present invention include, but are not limited to ammonium salts; alkali metal salts such as sodium and potassium; alkaline earth metal salts such as calcium and magnesium; salts with organic bases such as dicyclohexylamine, meglumine, N-methyl-D-glucamine, tris-(hydroxymethyl)-methylamine (tromethamine), and salts with amino acids such as arginine, lysine, *etc.* Compounds of the present invention which comprise basic nitrogen-containing groups may be quaternized with such agents as (C_1-C_4) alkyl halides, *e.g.*, methyl, ethyl, *iso*-propyl and *tert*-butyl chlorides, bromides and iodides; di(C_1-C_4) alkyl sulfate, *e.g.*, dimethyl, diethyl and diamyl sulfates; (C_{10}-C_{18}) alkyl halides, *e.g.*, decyl, dodecyl, lauryl, myristyl and stearyl chlorides, bromides and iodides; and aryl-(C_1-C_4) alkyl halides, *e.g.*, benzyl chloride and phenethyl bromide. Such salts permit the preparation of both water-soluble and oil-soluble compounds of the present invention.

Among the above-recited pharmaceutical salts those which are preferred include, but are not limited to acetate, besylate, citrate, fumarate, gluconate, hemisuccinate, hippurate, hydrochloride, hydrobromide, isethionate, mandelate, meglumine, nitrate, oleate, phosphonate, pivalate, sodium phosphate, stearate, sulfate, sulfosalicylate, tartrate, thiomalate, tosylate, and tromethamine.

Multiple salts forms are included within the scope of the present invention where a compound of the present invention contains more than one group capable of forming such pharmaceutically acceptable salts. Examples of typical multiple salt forms include, but are not limited to bitartrate, diacetate, difumarate, dimeglumine, diphosphate, disodium, and trihydrochloride.

The compounds of this invention can be administered alone but will generally be administered in admixture with one or more suitable pharmaceutical excipients, diluents or

carriers selected with regard to the intended route of administration and standard pharmaceutical practice.

For example, the compounds of the formula (I) can be administered orally or sublingually in the form of tablets, capsules, ovules, elixirs, solutions or suspensions, which may contain flavouring or colouring agents, for immediate or controlled release applications.

Such tablets may contain excipients such as microcrystalline cellulose, lactose, sodium citrate, calcium carbonate, dicalcium phosphate and glycine, disintegrants such as starch (preferably corn, potato or tapioca starch), alginic acid and certain complex silicates, and granulation binders such as polyvinylpyrrolidone, sucrose, gelatin and acacia. Additionally, lubricating agents such as magnesium stearate, sodium lauryl sulfate and talc may be included.

Solid compositions of a similar type may also be employed as fillers in gelatin capsules. Preferred excipients in this regard include lactose or milk sugar as well as high molecular weight polyethylene glycols. For aqueous suspensions and/or elixirs, the compounds of the formula (I) may be combined with various sweetening or flavouring agents, colouring matter or dyes, with emulsifying and/or suspending agents and with diluents such as water, ethanol, propylene glycol and glycerin, and combinations thereof.

The compounds of the formula (I) can also be injected parenterally, for example, intravenously, intraperitoneally, intrathecally, intraventricularly, intrasternally, intracranially, intramuscularly or subcutaneously, or they may be administered by infusion techniques. They are best used in the form of a sterile aqueous solution which may contain other substances, for example, enough salts or glucose to make the solution isotonic with blood. The aqueous solutions should be suitably buffered (preferably to a pH of from 3 to 9), if necessary. The preparation of suitable parenteral formulations under sterile conditions is readily accomplished by standard pharmaceutical techniques well known to those skilled in the art.

For oral and parenteral administration to human patients, the daily dosage level of the compounds of the formula (I) will usually be from 1 microgram/kg to 25 mg/kg (in single or divided doses).

Thus tablets or capsules of the compound of the formula (I) may contain from 0.05 mg to 1.0 g of active compound for administration singly or two or more at a time, as appropriate. The physician in any event will determine the actual dosage which will be most suitable for any individual patient and it will vary with the age, weight and response of the particular patient. The above dosages are exemplary of the average case. There can, of course, be individual instances where higher or lower dosage ranges are merited and such are within the scope of this invention.

The compounds of formula (I) can also be administered intranasally or by inhalation and are conveniently delivered in the form of a dry powder inhaler or an aerosol spray presentation from a pressurised container or a nebuliser with the use of a suitable propellant, eg dichlorodifluoromethane, trichlorofluoromethane, dichlorotetrafluoroethane, a hydrofluoroalkane such as 1,1,1,2-tetrafluorethane (HFA 134a), carbon dioxide or other suitable gas. In the case of a pressurised aerosol, the dosage unit may be determined by providing a valve to deliver a metered amount. The pressurised container or nebuliser may contain a solution or suspension of the active compound, eg using a mixture of ethanol and the propellant as the solvent, which may additional contain a lubricant, eg sorbitan trioleate. Capsules and cartridges (made, for example, from gelatin) for use in an inhaler or insufflator may be formulated to contain a powder mix of a compound of the formula (I) and a suitable powder base such as lactose or starch.

Aerosol or dry powder formulations are preferably arranged so that each metered dose or "puff" contains from 20 μg to 20 mg of a compound of the formula (I) for delivery to the patient. The overall daily dose with an aerosol will be in the range of from 20 μg to 20 mg which may be administered in a single dose or, more usually, in divided doses throughout the day.

Alternatively, the compounds of the formula (I) can be administered in the form of a suppository or pessary, or they may be applied topically in the form of a lotion, solution, cream, ointment or dusting powder. The compounds of the formula (I) may also be transdermally administered by the use of a skin patch. They may also be administered by the ocular route, particularly for treating neurological disorders of the eye.

For ophthalmic use, the compounds can be formulated as micronised suspensions in isotonic, pH adjusted, sterile saline, or, preferably, as solutions in isotonic, pH adjusted, sterile saline, optionally in combination with a preservative such as benzylalkonium chloride. Alternatively, they may be formulated in an ointment such as petrolatum.

For application topically to the skin, the compounds of the formula (I) can be formulated as a suitable ointment containing the active compound suspended or dissolved in, for example, a mixture with one or more of the following: mineral oil, liquid petrolatum, white petrolatum, propylene glycol, polyoxyethylene polyoxypropylene compound, emulsifying wax and water. Alternatively, they can be formulated as a suitable lotion or cream, suspended or dissolved in, for example, a mixture of one or more of the following: mineral oil, sorbitan monostearate, a polyethylene glycol, liquid paraffin, polysorbate 60, cetyl esters wax, cetearyl alcohol, 2-octyldodecanol, benyl alcohol and water.

The compounds of Formula (I) are described herein as possessing biological activity such that they are able to modulate CCR5 chemokine receptor activity and consequent or

associated pathogenic processes subsequently mediated by the CCR5 receptor and its ligands. The expression "modulate CCR5 chemokine receptor activity" as used herein is intended to refer to manipulation of the basic physiological processes and agencies which involve CCR5 chemokine receptors and their ligands. Included within the scope of this intended meaning are all types and subtypes of CCR5 receptors, in whatever tissues of a particular patient they are found, and in or on whatever components of the cells comprising those tissues they may be located. Most commonly, CCR5 receptors are situated on the cell membranes of particular cell types such as monocytes. CCR5 receptors participate in and define, along with various endogenous ligands to which they are naturally bound, signaling pathways which control important cellular and tissue functions by means of the influence which they exert on the movement of agents such as the chemokines, into and out of those cells and tissues.

The basic functioning of the CCR5 receptors and their ligands may be modulated in a number of ways, and the scope of the present invention is not limited in that regard to any particular existing or hypothesized pathway or process. Thus, included within the intended meaning of modulation of CCR5 chemokine receptor activity, is the use of synthetically derived modulators introduced into a patient being treated, such as the compounds of Formula (I) described herein. These exogenous agents may modulate CCR5 receptor activity by such well known mechanisms as competitive binding in which the natural ligands are displaced and their inherent functions disrupted. However, the present invention is not limited to any such specific mechanism or mode of action. Thus, "modulation" as used herein is intended to encompass preferably antagonism, but also agonism, partial antagonism and/or partial agonism. Correspondingly, the term "therapeutically effective amount" means the amount of the subject compound that will elicit the biological or medical response of a tissue, system, animal or human that is being sought.

The term "patient" in this specification refers particularly to humans. However the compounds, methods and pharmaceutical compositions of the present invention may be used in the treatment of animals.

Further included within the scope of the present invention are metabolites or residues of the compounds of Formula (I) which possess biological activity such that they are able to modulate CCR5 chemokine receptor activity and consequent or associated pathogenic processes subsequently mediated by the CCR5 receptor and its ligands. Once synthesized, the CCR5 chemokine receptor modulating activities and specificities of the compounds of Formula (I) according to the present invention may be determined using *in vitro* and *in vivo* assays which are described in detail further below.

The desirable biological activity of the compounds of Formula (I) may also be improved by appending thereto appropriate functionalities which enhance existing biological properties of the compound, improve the selectivity of the compound for the existing biological activities, or add to the existing biological activities further desirable biological activities. Such modifications are known in the art and include those which increase biological penetration into a given biological system, *e.g.*, blood, the lymphatic system, and central nervous system; increase oral availability; increase solubility to allow administration by injection; alter metabolism; and alter the rate of excretion of the compound of Formula (I).

The dosage and dose rate of the compounds of Formula (I) effective for treating or preventing diseases and conditions in a patient which are mediated by or associated with modulation of CCR5 chemokine receptor activity as described herein, as well as for favorably affecting the outcome thereof in said patient, in accordance with the methods of treatment of the present invention comprising administering to said patient a therapeutically effective amount of a compound of Formula (I), will depend on a variety of factors such as the nature of the active ingredient, the size of the patient, the goal of the treatment, the nature of the pathology being treated, the specific pharmaceutical composition used, the concurrent treatments that the patient may be subject to, and the observations and conclusions of the treating physician.

Generally, however, the effective therapeutic dose of a compound of Formula (I) which will be administered to a patient will be between about 10 μg (0.01 mg)/kg and about 60.0 mg/kg of body weight per day, preferably between about 100 μg (0.1 mg)/kg and about 10 mg/kg of body weight per day, more preferably between about 1.0 mg/kg and about 6.0 mg/kg of body weight per day, and most preferably between about 2.0 mg/kg and about 4.0 mg/kg of body weight per day of the active ingredient of Formula (I).

Included within the scope of the present invention are embodiments comprising coadministration of, and compositions which contain, in addition to a compound of the present invention as active ingredient, additional therapeutic agents and active ingredients. Such multiple drug regimens, often referred to as combination therapy, may be used in the treatment and prevention of any of the diseases or conditions mediated by or associated with CCR5 chemokine receptor modulation, particularly infection by human immunodeficiency virus, HIV. The use of such combinations of therapeutic agents is especially pertinent with respect to the treatment and prevention of infection and multiplication within a patient in need of treatment or one at risk of becoming such a patient, of the human immunodeficiency virus, HIV, and related pathogenic retroviruses. The ability of such retroviral pathogens to evolve within a relatively short period of time into strains resistant to any monotherapy which has been administered to said patient is well known in the technical literature.

In addition to the requirement of therapeutic efficacy which may necessitate the use of active agents in addition to the CCR5 chemokine receptor modulating compounds of Formula (I), there may be additional rationales which compel or highly recommend the use of combinations of drugs involving active ingredients which represent adjunct therapy, *i.e.*, which complement and supplement the function performed by the CCR5 chemokine receptor modulating compounds of the present invention. Such supplementary therapeutic agents used for the purpose of auxiliary treatment include drugs which, instead of directly treating or preventing a disease or condition mediated by or associated with CCR5 chemokine receptor modulation, treat diseases or conditions which directly result from or indirectly accompany the basic or underlying CCR5 chemokine receptor modulated disease or condition. For example, where the basic CCR5 chemokine receptor modulated disease or condition is HIV infection and multiplication, it may be necessary or at least desirable to treat opportunistic infections, neoplasms, and other conditions which occur as the result of the immune-compromised state of the patient being treated. Other active agents may be used with the compounds of Formula (I), *e.g.*, in order to provide immune stimulation or to treat pain and inflammation which accompany the initial and fundamental HIV infection.

Thus, the methods of treatment and pharmaceutical compositions of the present invention may employ the compounds of Formula (I) in the form of monotherapy, but said methods and compositions may also be used in the form of multiple therapy in which one or more compounds of Formula (I) are coadministered in combination with one or more known therapeutic agents such as those described in detail further herein.

The present invention also provides methods of treatment in which said pharmaceutical compositions are administered to a patient. Such methods relate to treating or preventing a disease or condition by modulating CCR5 chemokine receptor activity and consequent or associated pathogenic processes subsequently mediated by the CCR5 receptor and the active ligands with which it interacts or is bound. CCR5 and the other chemotactic cytokine, *i.e.*, chemokine, receptors, play a key role in the control of a number of processes which take place in the bodies of animals. Chemokine receptors, of which more than forty different species divided into four families are presently known to exist, are proteins having a number of structural features in common, which act through chemical signaling. In the α family of chemokines, one amino acid (X) separates the first two cysteine residues, while in the β-chemokines the first two cysteine residues are adjacent to each other (C-C). Accordingly, these two families are identified as CXC and CC chemokines, respectively. The chemokines bind specific cell-surface receptors belonging to the family of G-protein-coupled seven-transmembrane-domain proteins called "chemokine receptors", named in accordance with the class of chemokines which they bind, followed by "R" and a number. Thus, "CCR5" is a C-C chemokine receptor. See Horuk, *Trends Pharm. Sci.*, **15**,159-165 (1994) for further

details. CCR5 thus belongs to the β-chemokine receptor family, which is currently known to contain eight members, CCR1 through CCR8.

The CC type of chemokine receptor interacts with various signaling proteins, including the monocyte chemoattractant proteins, MCP-1, -2, -3, -4, and -5; eotaxin-1; macrophage inflammatory proteins MIP-1α, and MIP-1β; and those regulated upon activation which are normal T-cell expressed and secreted, RANTES. The CCR5 type of chemokine receptor in particular is known to interact with MIP-1α, MIP-1β; and RANTES in monocytes, activated T cells, dendritic cells, and natural killer cells. These β-chemokines do not act on neutrophils but rather attract monocytes, eosinophils, basophils, and lymphocytes with varying degrees of selectivity.

The present invention relates to compounds of Formula (I) which are useful in treating or preventing HIV infection, and to methods of treatment and pharmaceutical compositions containing such compounds as the active ingredient. It will be understood that the term "HIV" as used herein refers to human immunodeficiency virus (HIV), which is the etiological agent of AIDS (acquired immune deficiency syndrome), a disease that results in progressive destruction of the immune system and degeneration of the central and peripheral nervous system. Several HIV replication inhibitors are currently used as therapeutic or prophylactic agents against AIDS, and numerous others are presently under investigation.

In addition to cell-surface CD4, it has recently been shown that for entry into target cells, human immunodeficiency viruses require a chemokine receptor, CCR5 and CXCR-4 among others, as well as the virus's primary receptor CD4. The principal cofactor for entry mediated by the envelope glycoproteins of primary macrophage-tropic strains of HIV-1 is CCR5, which as already mentioned, is a receptor for the β-chemokines RANTES, MIP-1α and MIP-1β. See Deng, *et al.*, *Nature*, **381**, 661-666 (1996) for a further description of CCR5 mediated HIV entry.

HIV attaches to the CD4 molecule on cells through a region of its envelope protein, gp120, and gp120 is part of a multi-subunit complex, most likely a trimer of gp160, *i.e.*, gp120 + gp41. It is believed that the CD4 binding site on the gp120 of HIV interacts with the CD4 molecule on the cell surface, triggering conformational changes across the trimer, which allow it to bind to another cell-surface receptor, such as CCR5. This in turn enables gp41 to induce fusion with the cell membrane, and entry of the viral core into the cell. In addition, macrophage-tropic HIV and SIV envelope proteins have been shown to induce a signal through CCR5 on CD4+ cells, which may enhance the replication of the virus. See Weissman, *et al.*, *Nature*, **389**, 981-985 (1997) for a description of this phenomenon. Further, it has been shown that a complex of gp120 and soluble CD4 interacts specifically with CCR5 and inhibits the binding of the natural CCR5 ligands, as described in Wu, *et al.*, *Nature*, **384**,

179-183 (1996); and Trkola, *et al.*, *Nature*, **384**, 184-187 (1996). It has further been demonstrated that β-chemokines and related molecules, *e.g.*, (AOP)-RANTES, prevent HIV fusion to the cell membrane and subsequent infection, both *in vitro*, as described in Dragic, *et al.*, *Nature*, **381**, 667-673 (1996), and in animal models. Finally, absence of CCR5 appears to confer protection from HIV-1 infection, as described in *Nature*, **382**, 668-669 (1996). In particular, an inherited frame-shifting mutation in the CCR5 gene, Δ32, has been shown to abolish functional expression of the gene *in vitro*, and individuals homozygous for the mutation are apparently not susceptible to HIV infection, while at the same time they do not seem to be immuno-compromised by this variant. Furthermore, those heterozygote individuals that have been infected by HIV progress more slowly to full-blown clinical AIDS. In addition to validating the role of CCR5 in the infectious cycle of HIV, the above observations suggest that CCR5 is dispensable in the adult organism.

Although most HIV-1 isolates studied to date utilize CCR5 or CXCR-4, at least nine other chemokine receptors, or structurally related molecules, have also been described as supporting HIV-1 env-mediated membrane fusion or viral entry *in vitro*. These include CCR2b, CCR3, BOB/GPR15, Bonzo/STRL33/TYMSTR, GPR1, CCR8, US28, V28/CX3CR1, LTB-4, and APJ. There is good evidence that CCR3 can be used efficiently by a significant fraction of HIV-1 isolates *in vitro*, provided that this protein is over-expressed in transfected cells. Nevertheless, consistent evidence indicates that anti-HIV drugs targeted to chemokine receptors may not be compromised by this variability. Indeed, the chemokines RANTES, MIP-1α, MIP-1β, SDF-1 have been shown to suppress replication of primary HIV isolates. A derivative of RANTES, (AOP)-RANTES, is a sub-nanomolar antagonist of CCR5 function in monocytes. Monoclonal antibodies to CCR5 have been reported to block infection of cells by HIV *in vitro*. A small molecule antagonist of CXCR4, identified as AMD3100, has been reported to inhibit infection of susceptible cultures by CXCR4 dependent primary and lab-adapted HIV viruses while another small molecule called TAK 779 blocks entry of CCR5-tropic strains (Baba, *et al. PNAS*, **96** (10), 5698-5703 (1999); In addition, the majority of primary strains from early and late disease stages utilize CCR5 exclusively or in addition to other chemokine receptors, indicating that CCR5 dependent infection may play an essential role in the initiation and maintenance of productive HIV infection in a host. Accordingly, an agent which blocks CCR5 in patients including mammals, and especially humans who possess normal chemokine receptors, can reasonably be expected to prevent infection in healthy individuals and slow or halt viral progression in infected patients.

Accordingly, the present invention is directed to the compounds of Formula (I) which inhibit the entry of human immunodeficiency virus into target cells and are therefore of value in the prevention and/or treatment of infection by HIV, as well as the prevention and/or treatment

of the resulting acquired immune deficiency syndrome (AIDS). Evidence can be produced which is probative of the fact that the compounds of Formula (I) described herein inhibit viral entry through selective blockade of CCR5 dependent fusion. Consequently, the present invention also relates to pharmaceutical compositions containing the compounds of Formula (I) as an active ingredient, as well as to the corresponding method of use of the compounds of Formula (I) as stand-alone agents, or in conjunction with other agents for the prevention and treatment of infection by HIV and resulting AIDS.

The utility of the compounds of Formula (I) of the present invention as inhibitors of HIV infection may be demonstrated by any one or more methodologies known in the art, such as the HIV microculture assays described in Dimitrov *et al.*, *J. Clin. Microbiol.* **28**, 734-737 (1990)), and the pseudotyped HIV reporter assay described in Connor *et al.*, *Virology* **206** (2) 935-44 (1995). In particular, specific compounds of Formula (I) disclosed herein as preferred embodiments are shown to inhibit p24 production following replication of laboratory-adapted and primary HIV strains in primary blood lymphocytes (PBLs) and clonal cell-lines known to support replication of both CCR5 and CXCR-4 tropic viruses, *e.g.*, PM-1 and MOLT4-clone 8. It is also noted that only those viral strains known to use CCR5 are shown to be inhibited, whereas replication of CXCR-4 tropic viruses is shown to be unaffected, indicating that compounds of Formula (I) disclosed herein are able to prevent viral entry through selective blockade of CCR5 dependent fusion. Furthermore, compounds of Formula (I) are shown to inhibit entry of chimeric HIV reporter viruses pseudotyped with envelope from a CCR5 dependent strain (ADA). Finally, compounds of Formula (I) are shown to inhibit infection of primary cells by HIV isolated from infected patient blood. Further confirmation of this anti-HIV mechanism is provided by experiments outlined below.

The ability of the compounds of Formula (I) to modulate chemokine receptor activity is demonstrated by methodology known in the art, such as the assay for CCR5 binding following procedures disclosed in Combadiere *et al.*, *J. Leukoc. Biol.* **60**, 147-52 (1996); and/or intracellular calcium mobilisation assays as described by the same authors. Cell lines expressing the receptor of interest include those naturally expressing the receptor, such as PM-1, or IL-2 stimulated peripheral blood lymphocytes (PBL), or a cell engineered to express a recombinant receptor, such as CHO, 300.19, L1.2 or HEK-293. In particular, the compounds of Formula (I) disclosed herein are shown to have activity in preventing binding of all known chemokine ligands to CCR5 in the above-mentioned binding assays. In addition, the compounds of Formula (I) disclosed herein are shown to prevent intracellular calcium mobilization in response to endogenous agonists, which is consistent with their functioning as CCR5 antagonists. For the treatment of infection by HIV and the prevention and/or treatment of the resulting acquired immune deficiency syndrome (AIDS), compounds of Formula (I)

which are shown to be antagonists are preferred to compounds of Formula (I) which are shown to be agonists.

The present invention in one of its preferred embodiments is directed to the use of the compounds of Formula (I) disclosed herein for the prevention or treatment of infection by a retrovirus, in particular, the human immunodeficiency virus (HIV) and the treatment and/or delaying of the onset of consequent pathological conditions, including but no limited to AIDS. The expressions "treating or preventing AIDS", and "preventing or treating infection by HIV" as used herein are intended to mean the treatment of a wide range of states of HIV infection: AIDS, ARC (AIDS related complex), both symptomatic and asymptomatic, and actual or potential exposure to HIV. The quoted expressions are not intended, however, to be limited to the recited treatments, but rather are contemplated to include all beneficial uses relating to conditions attributable to an AIDS causative agent. For example, the compounds of Formula (I) are useful in treating infection by HIV after suspected past exposure to HIV by, *e.g.*, blood transfusion, organ transplant, exchange of body fluids, sexual intercourse, bites, needle stick, or exposure to patient blood. In addition, a compound of Formula (I) may be used for the prevention of infection by HIV and the prevention of AIDS, such as in pre-or post-coital prophylaxis or in the prevention of maternal transmission of the HIV virus to a fetus or a child, whether at the time of birth, during the period of nursing, or in any other manner as above-described.

In a preferred embodiment of the present invention, a compound of Formula (I) may be used in a method of inhibiting the binding of human immunodeficiency virus to a chemokine receptor such as CCR5, which comprises contacting the target cell with a therapeutically effective amount of a compound of Formula (I) which is effective to inhibit the binding of the virus to the chemokine receptor. The subject treated by these preferred methods of the present invention is a mammal, preferably a human, male or female, in whom modulation of chemokine receptor activity is desired and contemplated to be efficacious. As already pointed out, the term "modulation" as used herein is intended to encompass preferably antagonism, but also agonism, partial antagonism and/or partial agonism. Also, the expression "therapeutically effective amount" as used herein is intended to mean the amount of a compound of Formula (I) as disclosed herein that will elicit the biological or medical response of a tissue, system, or animal, especially human that is being sought.

In another preferred embodiment of the present invention, a compound of Formula (I) may be used to evaluate putative retrovirus, especially HIV, mutants considered to be resistant to anti-HIV therapeutic agents, including the compounds of Formula (I) disclosed herein. Mutant viruses may be isolated from *in vitro* cultures by methods known in the art, but may also be isolated from *in vivo* animal infection models which have been disclosed in the art. More significantly, mutant viruses may be isolated from samples of patients undergoing

treatment, whether optimal or sub-optimal, comprising administration of a compound of Formula (I), or any combination thereof with other known or to-be-discovered therapeutic agents. Such mutant viruses or their components, particularly their envelope proteins, may be used for several advantageous purposes, including but not limited to the following: (*i*) the evaluation and/or development of novel chemokine modulators or other agents having improved activity against such mutant viruses; and (*ii*) the development of diagnostics capable of assisting physicians or other clinicians in the choice of a therapeutic regimen and/or outcome prediction for a patient.

In a further preferred embodiment of the present invention, compounds of Formula (I) disclosed herein are used as tools for determining the co-receptor affinity of retroviruses including HIV and SIV, or their components, especially their envelope proteins. This affinity data can be used for several advantageous purposes, including but not limited to phenotyping a given viral population, *e.g.* prior to administration of anti-retroviral therapy. The affinity data may also be used to predict the progression and outcome of the infection by the virus population involved.

In another preferred embodiment of the present invention, a compound of Formula (I) is used in the preparation and execution of screening assays for compounds which modulate the activity of chemokine, especially CCR5 receptors. For example, compounds of Formula (I) as disclosed herein are useful for isolating receptor mutants, which can then be made into screening tools for the discovery of even more potent compounds, following procedures well known in the art. Furthermore, the compounds of Formula (I) are useful in establishing or characterizing the binding sites of other ligands, including compounds other than those of Formula (I) and viral envelope proteins, to chemokine receptors, *e.g.*, by competitive inhibition. The compounds of Formula (I) are also useful for the evaluation of putative specific modulators of various chemokine receptors. As will be appreciated by the artisan, thorough evaluation of specific agonists and antagonists of the above-described chemokine receptors has been hampered by the lack of non-peptidyl, *i.e.*, metabolically resistant compounds with high binding affinity for these receptors. Thus, the compounds of Formula (I) are useful as products which may be commercially exploited for these and other beneficial purposes.

Included within the scope of the present invention are combinations of the compounds of Formula (I) with one or more therapeutic agents useful in the prevention or treatment of AIDS. For example, the compounds of the present invention may be effectively administered, whether at periods of pre-exposure and/or post-exposure to HIV, in combination with therapeutically effective amounts of known AIDS antivirals, immunomodulators, anti-infectives, or vaccines familiar to those skilled in the art. It will be understood that the scope of such combinations which include the compounds of Formula (I) is not limited to the above-recited

list, but includes as well any combination with another pharmaceutically active agent which is useful for the prevention or treatment of HIV and AIDS.

Preferred combinations of the present invention include simultaneous, or sequential treatments with a compound of Formula (I) and one or more inhibitors of HIV protease and/or inhibitors of HIV reverse transcriptase, preferably selected from the class of non-nucleoside reverse transcriptase inhibitors (NNRTI), including but not limited to nevirapine, delavirdine, and efavirenz; from among the nucleoside/nucleotide inhibitors, including but not limited to zidovudine, didanosine, zalcitabine, stavudine, lamivudine, abacavir, and adefovir dipivoxil; and from among the protease inhibitors, including but not limited to indinavir, ritonavir, saquinavir, nelfinavir, and amprenavir. Other agents useful in the above-described preferred embodiment combinations of the present invention include current and to-be-discovered investigational drugs from any of the above classes of inhibitors, including but not limited to FTC, PMPA, fozivudine tidoxil, talviraline, S-1153, MKC-442, MSC-204, MSH-372, DMP450, PNU-140690, ABT-378, and KNI-764. There is also included within the scope of the preferred embodiments of the present invention, combinations of a compound of Formula (I) together with a supplementary therapeutic agent used for the purpose of auxiliary treatment, wherein said supplementary therapeutic agent comprises one or more members independently selected from the group consisting of proliferation inhibitors, *e.g.*, hydroxyurea; immunomodulators, *e.g.*, sargramostim, and various forms of interferon or interferon derivatives; fusion inhibitors, *e.g.*, AMD3100, T-20, PRO-542, AD-349, BB-10010 and other chemokine receptor agonists/antagonists; integrase inhibitors, *e.g.*, AR177; RNaseH inhibitors; inhibitors of viral transcription and RNA replication; and other agents that inhibit viral infection or improve the condition or outcome of HIV-infected individuals through different mechanisms.

Preferred methods of treatment of the present invention for the prevention of HIV infection, or treatment of aviremic and asymptomatic subjects potentially or effectively infected with HIV, include but are not limited to administration of a member independently selected from the group consisting of: (*i*) a compound within the scope of Formula (I) as disclosed herein; (*ii*) one NNRTI in addition to a compound of (*i*); (*iii*) two NRTI in addition to a compound of (*i*); (*iv*) one NRTI in addition to the combination of (*ii*); and (*v*) a compound selected from the class of protease inhibitors used in place of an NRTI in combinations (*iii*) and (*iv*).

The preferred methods of the present invention for therapy of HIV-infected individuals with detectable viremia or abnormally low CD4 counts further include as a member to be selected: (*vi*) treatment according to (*i*) above in addition to the standard recommended initial regimens for the therapy of established HIV infections, *e.g.*, as described in Bartlett, J. G.,

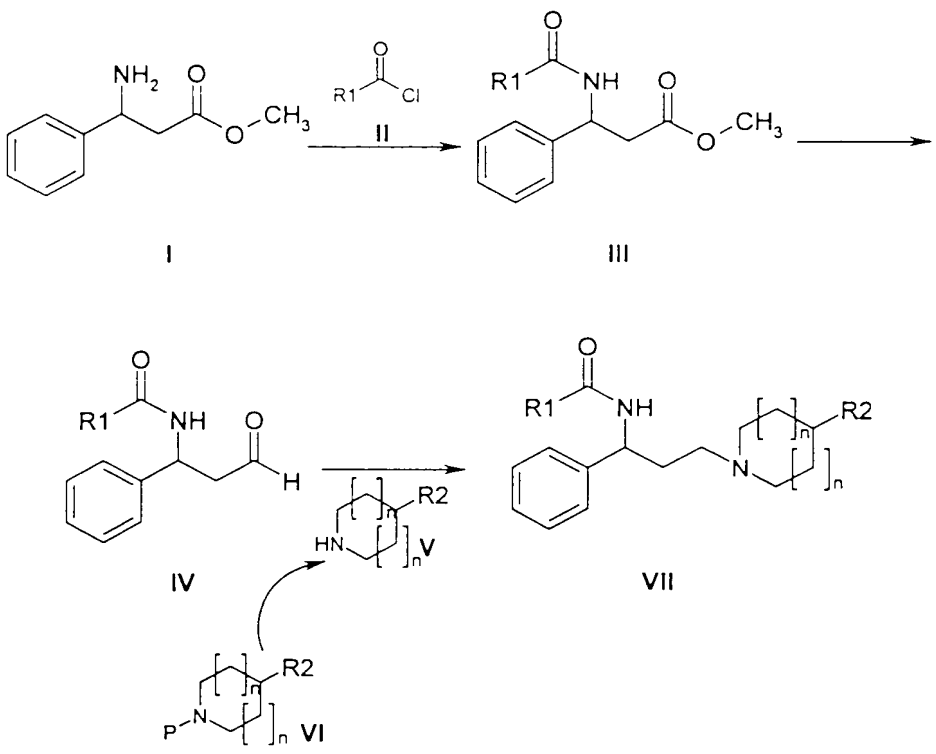
"1998 Medical management of HIV infection", Johns Hopkins University publishers, ISBN 0-9244-2809-0. Such standard regimens include but are not limited to an agent from the class of protease inhibitors in combination with two NRTIs; and (*vii*) a standard recommended initial regimens for the therapy of established HIV infections, *e.g.*, as described in Bartlett, J. G., "1998 Medical management of HIV infection", Johns Hopkins University publishers, ISBN 0-9244-2809-0), where either the protease inhibitor component, or one or both of the NRTIs is/are replaced by a compound within the scope of Formula (I) as disclosed herein. The preferred methods of the present invention for therapy of HIV-infected individuals that have failed antiviral therapy further include as a member to be selected: (*viii*) treatment according to (*i*) above, in addition to the standard recommended regimens for the therapy of such patients, *e.g.*, as described in Bartlett, J. G., "1998 Medical management of HIV infection", Johns Hopkins University publishers, ISBN 0-9244-2809-0); and (*ix*) a standard recommended initial regimens for the therapy of patients who have failed antiretroviral therapy, *e.g.*, as described in Bartlett, J. G., "1998 Medical management of HIV infection", Johns Hopkins University publishers, ISBN 0-9244-2809-0), where either one of the protease inhibitor components, or one or both of the NRTIs is/are replaced by a compound within the scope of Formula (I) as disclosed herein. In the above-described preferred embodiment combinations of the present invention, the compound of Formula (I) and other therapeutic active agents may be administered in terms of dosage forms either separately or in conjunction with each other, and in terms of their time of administration, either serially or simultaneously. Thus, the administration of one component agent may be prior to, concurrent with, or subsequent to the administration of the other component agent(s). The compounds of Formula (I) may be administered in accordance with a regimen of 1 to 4 times per day, preferably once or twice per day. The specific dose level and frequency of dosage for any particular patient may be varied and will depend upon a variety of factors including the activity of the specific compound employed, the metabolic stability and length of action of that compound, the age, body weight, general health, sex, diet, mode and time of administration, rate of excretion, drug combination, the severity of the particular condition, and the host undergoing therapy. In particular, however, the treatment of retroviral infections, and more particularly HIV, may be guided by genotyping and phenotyping the virus in the course of or prior to the initiation of administration of the therapeutic agent. In this way, it is possible to optimise dosing regimens and efficacy when administering a compound of Formula (I) for the prevention or treatment of infection by a retrovirus, in particular, the human immunodeficiency virus (HIV).

The compounds of this invention may be used for treatment of respiratory disorders, including: adult respiratory distress syndrome (ARDS), bronchitis, chronic bronchitis, chronic obstructive pulmonary disease, cystic fibrosis, asthma, emphysema, rhinitis and chronic sinusitis.

The invention is further described by means of examples, but not in any limitative sense. The following general synthetic routes were employed.

METHODS OF PREPARING COMPOUNDS OF THE PRESENT INVENTION

Synthesis I



n = 0 or 1

Compounds of formula **III** may be prepared by coupling the amino acid derivative of formula **I** with an acid chloride of formula **II** in the presence of a tertiary amine, such as triethylamine, in a suitable solvent, such as dichloromethane at between 0°C and room temperature. Compounds of formula **IV** may be prepared by reduction of compounds of formula **III,** using a suitable reducing agent, preferably diisobutylaluminium hydride in dichloromethane at -78°C.

Removal of the nitrogen protecting group (where P is a protecting group, is typically, benzyl, Boc, CBz or trifluoroacetate), from the amine of formula **VI**, may be achieved using standard methodology, to provide the amine of formula **V**. For example, Boc may be removed under conditions of protonolysis using hydrochloric acid or trifluoroacetic acid in a suitable solvent such as dichloromethane, methanol or tetrahydrofuran, at room temperature for between 2 and 15 hours. Removal of a benzyl or CBz group may be achieved under conditions of transfer catalytic hydrogenation, using a catalyst such as Pearlman's catalyst, in

the presence of excess ammonium formate, in a suitable solvent such as ethanol under reflux conditions. Alternatively, a benzyl group may be removed by treatment with 1-chloroethyl chloroformate in a suitable solvent such as dichloromethane at between 0°C and room temperature .

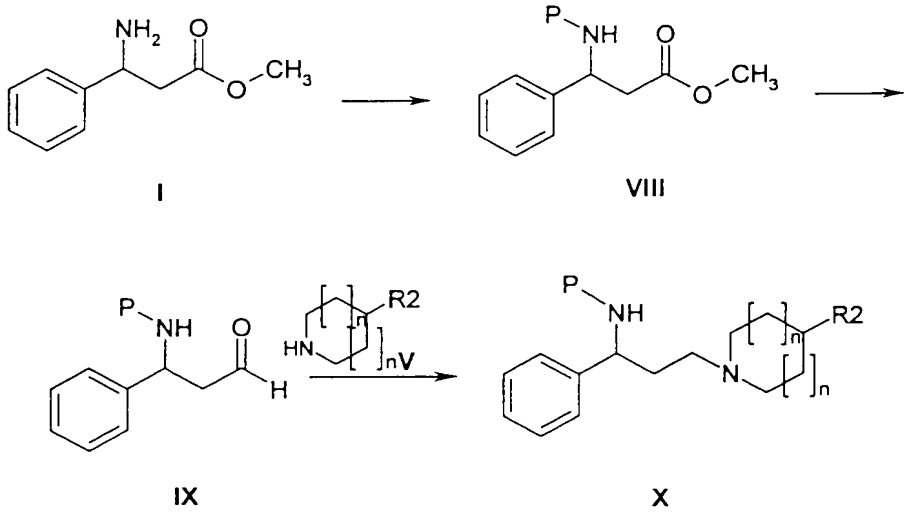
A trifluoroacetate protecting group may be removed under conditions of basic hydrolysis, using an excess of a suitable base such as sodium hydroxide, in an alcoholic solvent, typically methanol or ethanol, at room temperature.

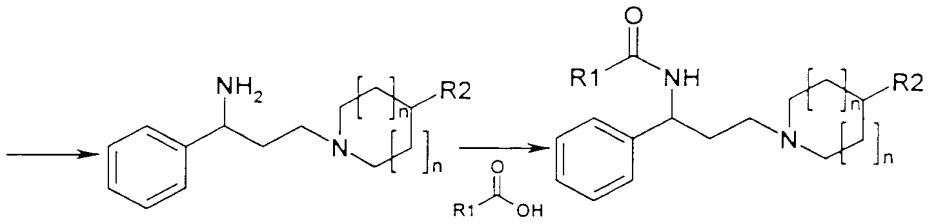
Compounds of the general formula **VII** may be prepared by the reductive alkylation of an appropriate amine of formula **V**, with an aldehyde, of formula **IV**. The reaction may be carried out in the presence of an excess of suitable reducing agent (e.g. sodium triacetoxyborohydride) in a protic solvent system (acetic acid in dichloromethane or 1,1,1-trichloroethane), at room temperature, for between 30 minutes and 18 hours.

Alternatively, a compound of formula **VII** may be prepared in a "one-pot" procedure, by deprotection of the nitrogen protecting group from the compound of formula **VI**, and reacting the intermediate amine **V**, with the aldehyde of formula **IV**, under conditions of reductive alkylation, using the methods described above.

When a compound of formula **I**, is required as a single enantiomer, it may be obtained according to the method of Davies et al. (J. Chem. Soc. Perk. Trans. I; 9; 1994; 1129).

Synthesis II



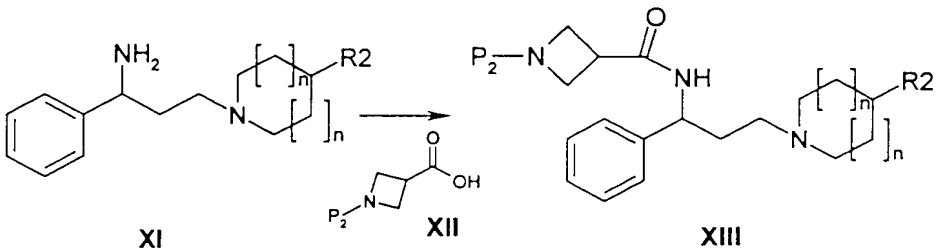


XI VII

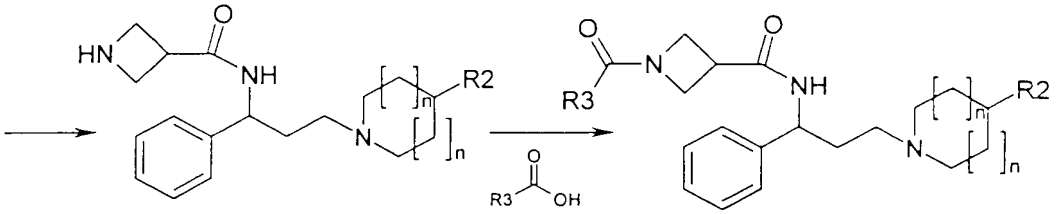
Preparation of the compounds of formula **VIII** from the amino acid derivative **I** where P is a suitable protecting group (preferably BOC), may be achieved for example, by reaction with di-*tert*-butyl dicarbonate in the presence of a base such as aqueous sodium hydroxide in a suitable solvent such as tetrahydrofuran. Compounds of formula **IX** may be prepared by reduction of compounds of formula **VIII**, according to the method described in synthesis I. Reductive alkylation of the amine of formula **V**, with the aldehyde of formula **IX**, according to the method described in synthesis I, may provide the compounds of formula **X**.

Subsequent removal of the nitrogen protecting group may be achieved, for example using trifluoroacetic acid or hydrochloric acid in a solvent such as methanol or dichloromethane at room temperature for from 1 to 60 hours to provide the compound of formula **XI**. Compounds of general formula **VII** may be prepared by coupling the amine of formula **XI** with an acid ($R1CO_2H$) using conventional amide bond forming techniques. For example, the acid may be activated using a carbodiimide such as 3-(3-dimethylamino-1-propyl)-1-ethylcarbodiimide, optionally in the presence of 1-hydroxybenzotriazole hydrate. These reactions may be performed in a suitable solvent such as dichloromethane, optionally in the presence of a tertiary amine, such as triethylamine or N-ethyldiisopropylamine at about room temperature.

Synthesis III



XI XII XIII



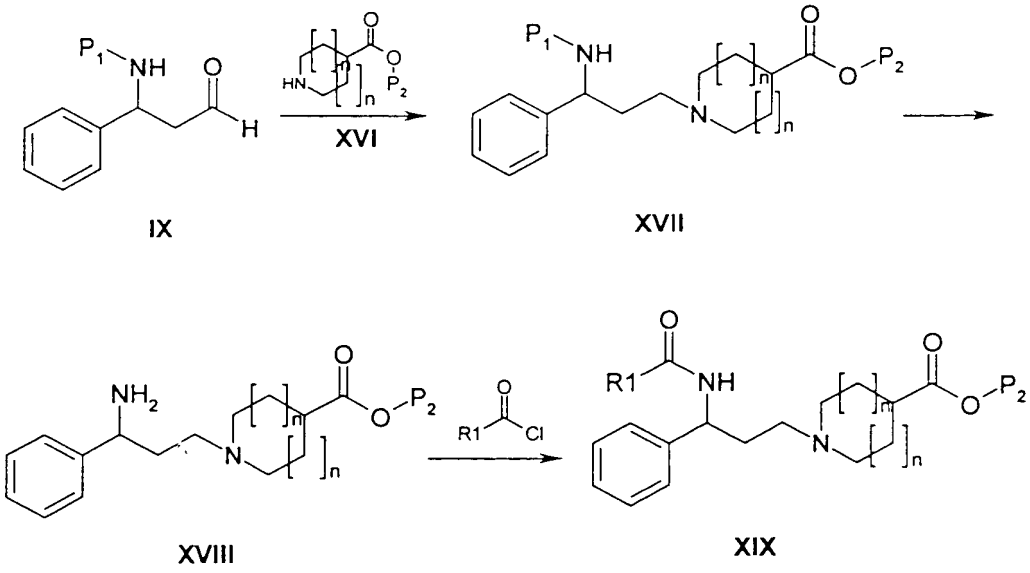
XIV XV

Compounds of the general formula **XIII** may be prepared by coupling the amine of formula **XI** with the protected amino acid of formula **XII** (P is a protecting group, typically BOC) using methods previously described in synthesis II. Removal of the nitrogen protecting group, using standard methodology such as protonolysis using trifluoroacetic acid, according to the methods previously described, provides the compound of formula **XIV.**

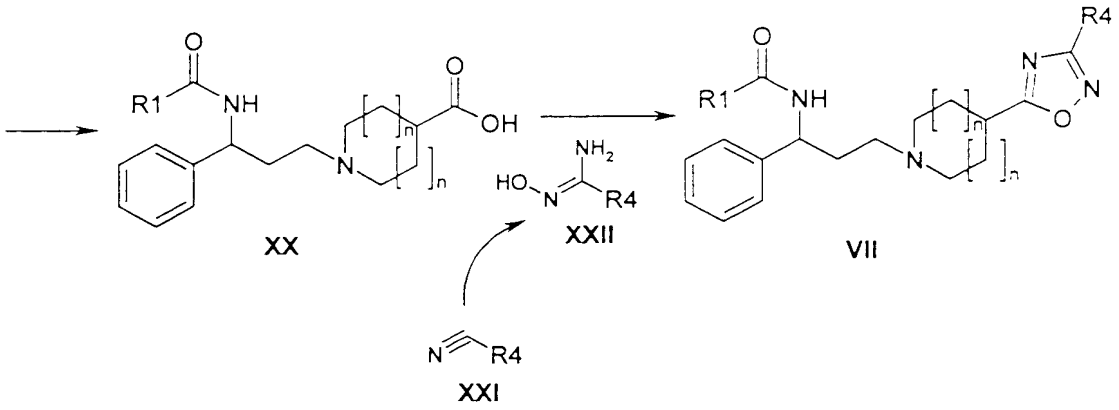
Alternatively, the amine of general formula **XIV** may be formed in a "one-pot" procedure, by coupling the amine of formula **XI** with the acid of formula **XII**, followed by deprotection of the resultant intermediate, using the methods previously described.

Compounds of formula **XV** may be prepared by coupling the amine of formula **XIV** with an acid ($R3CO_2H$), according to the methods described in synthesis II.

Synthesis IV



IX XVI XVII XVIII XIX



Compounds of general formula **XVII** may be prepared by reductive alkylation of the protected amine **XVI** (where P2 is preferably benzyl), with the aldehyde of general formula **IX** (where P1 is preferably Boc), according to the methods previously described. Removal of the nitrogen protecting group, P1, using conditions previously described, provides the amine of general formula **XVIII.** Compounds of formula **XIX** may be prepared by coupling the amine of formula **XVIII** with an acid chloride (R1COCl), in the presence of a tertiary amine, such as N-ethyldiisopropylamine, in a suitable solvent, such as dichloromethane at room temperature. Removal of the oxygen protecting group, from the compound of formula **XIX** using standard methodology provides the acid of formula **XX**. Typically removal of the benzyl group may be achieved under catalytic hydrogenation conditions using a catalyst such as palladium on charcoal, in an alcoholic solvent, preferably ethanol, at a hydrogen pressure of about 1 atm, and room temperature.

Compounds of formula **XXII** may be prepared from compounds of formula **XXI** using conventional techniques. For example, treatment of the nitrile of formula **XXI**, with a 5-fold excess of hydroxylamine hydrochloride, in the presence of a 5-fold excess of base, typically sodium carbonate or sodium methoxide, in a suitable solvent such as aqueous methanol, at room temperature, may provide compounds of formula **XXII**.

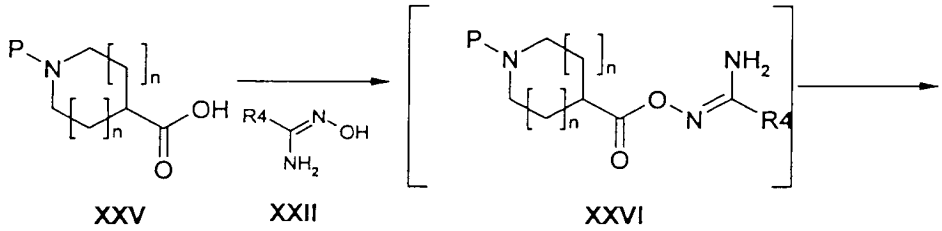
Compounds of formula **VII** may be prepared by coupling the acid of formula **XX** with an appropriate amidoxime of formula **XXII**, using conventional amide bond forming techniques, followed by in-situ cyclocondensation of the intermediate product.

For example, the acid may be activated using a carbodiimide such as 3-(3-dimethylamino-1-propyl)-1-ethylcarbodiimide, optionally in the presence of N-dimethylaminopyridine. These reactions may be performed in a solvent such as dichloromethane, optionally in the presence of a tertiary amine, such as N-methylmorpholine or N-ethyldiisopropylamine at about room temperature. Alternatively, the acid may be activated using a fluorinating agent, such as N,N,N',N'-bis(tetramethylene)fluoroformamidinium hexafluorophosphate (J.A.C.S. 1995; 117(19); 5401)

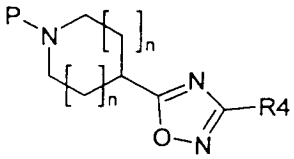
in the presence of a base such as N-ethyldiisopropylamine in a suitable solvent such as dichloromethane at room temperature. Cyclocondensation of the resultant intermediate may subsequently be achieved by heating in an appropriate solvent such as dioxane or toluene at elevated temperature (e.g. 130°C) for between 4 and 15 hours.

Alternatively, a compound of formula **VII** may be formed in a "one-pot procedure", by preparing the amidoxime of formula **XXII** from the nitrile of formula **XXI**, then coupling and cyclising the resultant intermediate with the acid of formula **XX** according to the methods described above.

Synthesis V



XXV **XXII** **XXVI**



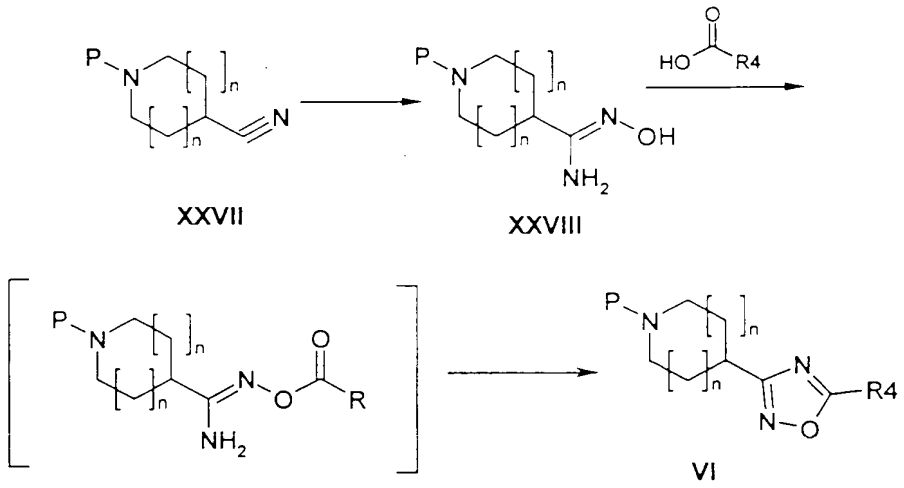
VI

n is independently 0 or 1.

Compounds of formula **VI** may be prepared by coupling the protected amino acid of formula **XXV** (where P is a protecting group, preferably trifluoroacetate) with an amidoxime of formula **XXII**, followed by cyclisation of the resultant intermediate. The acid amine coupling may be achieved using methods previously described in synthesis IV. Cyclisation of the resultant O-acylamidoxime intermediate, of formula **XXVI** to afford the compound of formula **VI**, may be achieved by heating in an appropriate solvent such as dioxane or toluene at elevated temperature (110°C) for about 18 hours.

Alternatively, in a variation of this "one-pot" procedure, the O-acylamidoxime may be isolated, and then cyclised using the methods described above.

Synthesis VI

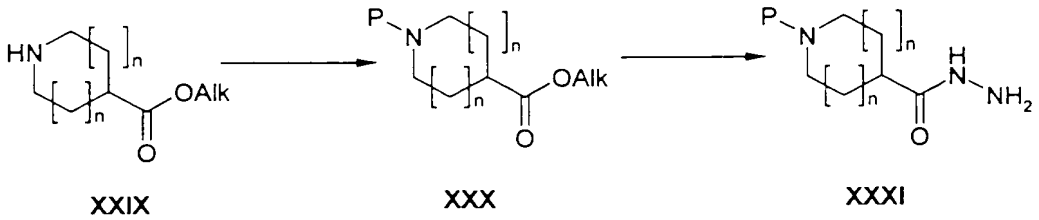


XXVII XXVIII VI

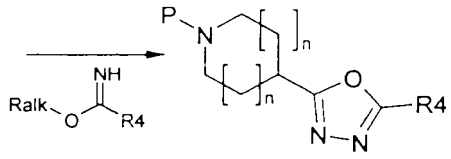
n = independently 0 or 1

The compound of formula **XXVIII** may be prepared from the protected nitrile of formula **XXVII** (where P is typically Boc), using standard methodology. Typically, the nitrile is treated with an excess of hydroxylamine hydrochloride in the presence of an excess of suitable base, such as sodium bicarbonate, in an appropriate solvent, (for example aqueous methanol) at reflux temperature for about 5 hours. The compounds of formula **VI** may be prepared by coupling the amidoxime of formula **XXVIII** with the acid (R_4CO_2H), and cyclisation of the resultant intermediate, according to the methods described in synthesis V.

Synthesis VII



XXIX XXX XXXI



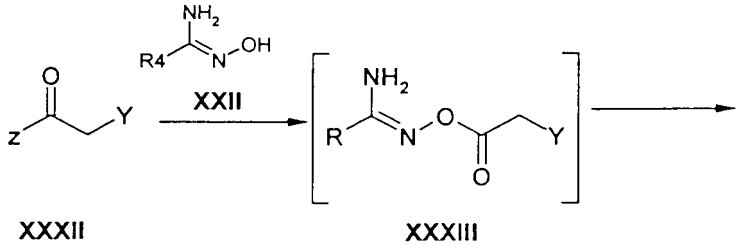
VI

Ralk = C1-C6 alkyl, preferably, C1-C2.

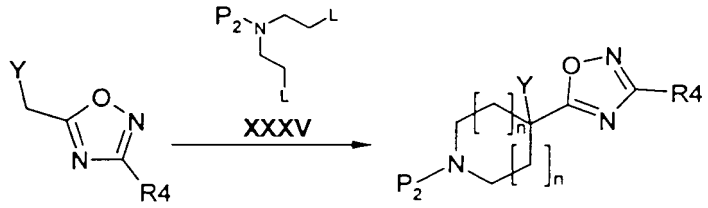
N = independently, 0 or 1

Preparation of the compounds of formula **XXX** from the amine **XXIX**, where P is a suitable protecting group (preferably BOC), may be achieved for example, by reaction with di-*tert*-butyl dicarbonate in the presence of a base such as aqueous sodium hydroxide in a suitable solvent such as dioxane or tetrahydrofuran. The hydrazide of formula **XXXI** may be prepared from the compound of formula **XXX**, using standard methodology. For example, the alkyl ester of formula **XXIX** may be treated with excess hydroxylamine, in an alcoholic solvent such as methanol, at the reflux temperature of the mixture. The compound of formula **VI** may be prepared by condensation of this hydrazide of formula **XXXI** with an excess of iminoether (RalkOC(NH)R4), in a suitable solvent such as ethanol, at reflux temperature for about 18 hours.

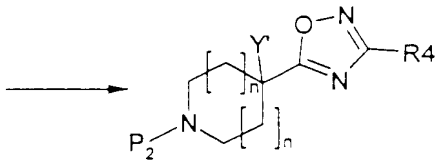
Synthesis VIII



XXXII XXXIII



XXXIV XXXVI



XXXVII

Compounds of general formula **XXXIII** may be prepared by coupling the hydroxylamine of formula **XXII** with an acid (Z = OH) or acid derivative (e.g. Z = Cl) of formula **XXXII** (Y is a carboxylic acid derived functional group, e.g. CO_2Et, CN) using conventional amide bond forming techniques, as described above.

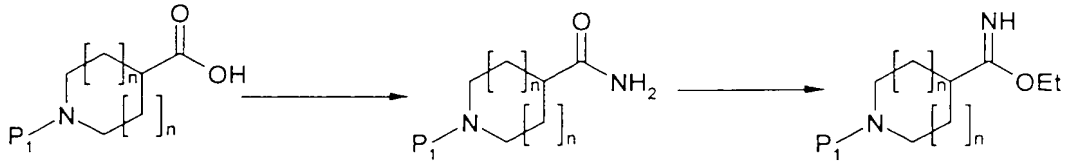
Alternatively an acyl chloride of formula **XXXII** may be reacted with the hydroxylamine of formula **XXII** in the presence of a tertiary amine, such as triethylamine or N-ethyldiisopropylamine in a suitable solvent such as dichloromethane at from about 10°C to about room temperature.

Cyclocondensation of the compounds of formula **XXXIII**, according to the methods described in synthesis V, may provide the compound of formula **XXXIV.**

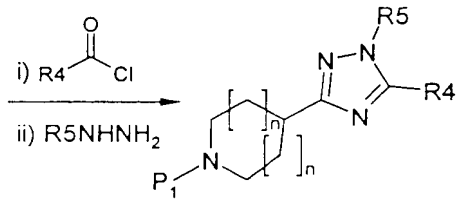
In a further variation, the compound of formula **XXXIV** may be formed in a "one-pot" procedure, by coupling the hydroxylamine of formula **XXII** with the acid derivative of formula **XXXII**, and cyclising the resultant intermediate, according to the methods described above. Compounds of formula **XXXVI** may be prepared by reaction of the compounds of formula **XXXIV**, with an alkylating agent of formula **XXXV** (where P is a protecting group preferably benzyl, and L is a leaving group, such as halo, and preferably chloro). This reaction may be performed in a suitable solvent such as 2-methylpyrrolidine, in the presence of an excess of base, such as sodium hydride, additionally in the presence of a catalyst, such as tetra-n-butylammonium bromide, at elevated temperature (e.g. 60°C).

Compounds of formula **XXXVII** may be prepared by functional group transformations, form compounds of formula **XXXVI**, using standard methodology. For example, the methylamide (Y' = CONHMe) may be prepared from the corresponding ethyl ester of formula **XXXVI**, by treatment with methylamine in a solvent such as tetrahydrofuran, in a sealed vessel at elevated temperature (e.g. 100°C).

Synthesis IX



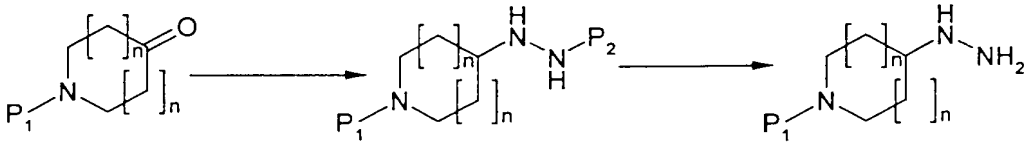
XXXVIII XXXIX XXXX



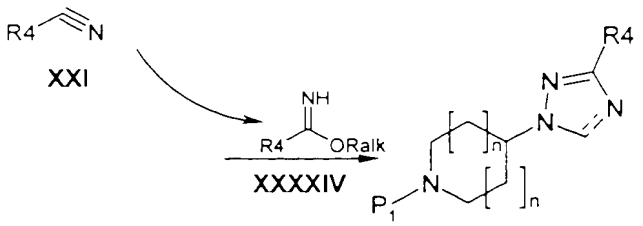
VI

Preparation of the compound of formula **XXXIX** from the protected amino acid of formula **XXXVIII** (where P is a suitable protecting group, preferably Boc), may be achieved for example, by reaction with ethyl chloroformate, in the presence of a tertiary amine, such as triethylamine, in a suitable solvent such as dichloromethane, followed by addition of aqueous ammonia, at room temperature. The compounds of formula **XXXX**, may be prepared by alkylation of the compounds of formula **XXXIX**, using an excess of suitable alkylating agent, such as triethyloxonium hexafluorophosphate, in a solvent such as dichloromethane at room temperature. Compounds of formula **VI** may be prepared by reaction of the compounds of formula **XXXX** with an acylating agent, typically an acyl chloride (R4COCl), in the presence of a tertiary amine, such as triethylamine, in a suitable solvent such as toluene, at room temperature for about an hour. Reaction of the resultant intermediate with an appropriate hydrazine ($R5NHNH_2$) for between 5 and 18 hours at room temperature may provide the compound of formula **VI**.

Synthesis X



XXXXI XXXXII XXXXIII



VI

Compounds of formula **XXXXII** may be prepared by the reductive alkylation of the protected carbonyl compound of formula **XXXXI** (P is typically benzyl), with a protected hydrazine ($P2NHNH_2$), where P2 is preferably Boc, according to the methods described above. Subsequent removal of the nitrogen protecting group using standard methodology, such as protonolysis using trifluoroacetic acid in dichloromethane, according to the methods previously described, may provide the compound of formula **XXXXIII**.

Compounds of formula **XXXXIV** may be prepared from the nitrile compound of formula **XXI**, by initial protonolysis using hydrochloric acid, in a suitable solvent such as diethyl ether, and treatment of the resultant intermediate with an alcohol, preferably methanol, at room temperature.

Alternatively, the imidate of formula **XXXXIV** may be prepared from the corresponding bromo compound, by treatment, for example, with an excess of 1,1,3,3-tetramethylguanidine and acetone cyanohydrin in a solvent such as acetonitrile, at room temperature.

Compounds of formula **VI**, may be prepared by coupling the hydrazine of formula **XXXXIII**, with the imidate of formula **XXXXIV**, in a suitable solvent such as dichloromethane or methanol, and cyclising the resultant intermediate in the presence of an appropriate orthoester, typically triethylorthoacetate or triethylorthoformate, at reflux temperature.

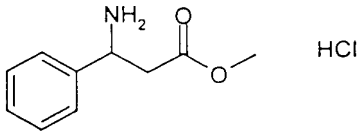
Alternatively, the compounds of formula **VI** may be prepared from the compounds of formula **XXXXIII** in a "one-pot" procedure, by deprotection of the nitrogen group, P2, coupling the product with the imidate of formula **XXXXIV**, and then cyclising the intermediate, according to the methods described above.

Compounds of formula **VI** may also be prepared according to one of the plethora of methods currently available. For example, the method of Lin et. Al (J. Org. Chem. 44; 23; 1979; 4160), provides 1,2,4-triazoles from compounds of formula **XXXIX** by reaction with N,N-dimethylformamide dimethylacetal, and the appropriate hydrazine. Alternatively, treatment of the compound of formula **XXXIX** with Lawesson's reagent, followed by reaction of the resulting thioamide intermediate with an appropriate hydrazide according to the method of Bull et al. (WO 9732873) may also provide compounds of formula **VI.**

In a further variation, nitrogen protected 4-piperidinamines (e.g. 1-benzyl-4-piperidinamine), may be treated with N,N-dimethylformamide azine (J.A.C.S. 1995; 117; 5951), to provide compounds of formula **VI**. The reaction may be performed in a suitable solvent, such as toluene in the presence of an acid catalyst, such as p-toluenesulphonic acid, at room temperature for about 24 hours.

PREPARATION 1

Methyl 3-amino-3-phenylpropanoate hydrochloride

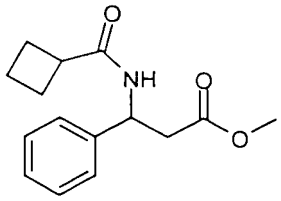


3-Phenyl-β-alanine (13.0g, 78.8mmol) was dissolved in methanolic hydrochloric acid (200ml, 2.25M). The reaction was heated under reflux for 18 hours, then the cooled mixture was concentrated under reduced pressure to afford the title compound as a yellow oil, 16.9g.

^{1}H-NMR (400MHz, CD_3OD) : δ [ppm] 3.00-3.19 (2H, m), 3.72 (3H, s), 4.74 (1H, t), 7.48 (5H, s)

PREPARATION 2

Methyl 3-[(cyclobutylcarbonyl)amino]-3-phenylpropanoate



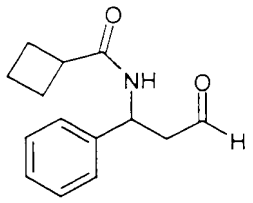
Cyclobutanecarbonyl chloride (6.91ml, 86.7mmol) was added dropwise to a solution of the title compound of preparation 1 (16.9g, 78.8mmol) and triethylamine (24.2ml, 173.4mmol) in dichloromethane (200ml) at 0°C. The reaction mixture was stirred for 56 hours at room temperature after which time the mixture was washed with water then brine, dried ($MgSO_4$), filtered and the solvent removed under reduced pressure to afford the title compound as a yellow oil, 20.8g.

^{1}H-NMR (400MHz, $CDCl_3$) : δ [ppm] 2.00-2.10 (2H, m), 2.10-2.35 (4H, m), 2.80-3.00 (2H, m), 3.03 (1H, m), 3.62 (3H, s), 5.42 (1H, m), 6.50 (1H, d), 7.25-7.35 (5H, m)

LRMS : m/z 262 (MH^+)

PREPARATION 3

N-(3-Oxo-1-phenylpropyl)cyclobutanecarboxamide



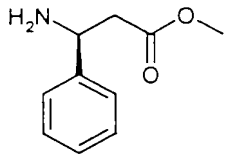
Diisobutylaluminium hydride (42.1ml of a 1.0M solution in dichloromethane, 42.1mmol) was added dropwise to a solution of the title compound of preparation 2 (5.0g, 19.1mmol) in dichloromethane (100ml) at -78°C. The reaction mixture was stirred at this temperature for an hour, then methanol (5ml) pre-cooled to -78°C was added. The mixture was warmed to room temperature and washed with 2M hydrochloric acid, water, brine, dried ($MgSO_4$), filtered and the solvent evaporated under reduced pressure to afford the title compound as a yellow oil, 3.3g.

^{1}H-NMR (400MHz, $CDCl_3$) : δ [ppm] 1.81-2.35 (6H, m), 2.90-3.10 (3H, m), 5.50 (1H, m), 6.00 (1H, br d), 7.23-7.39 (5H, m), 9.75 (1H, m)

LRMS : m/z 232 (MH^+)

PREPARATION 4

Methyl (3*S*)-3-amino-3-phenylpropanoate



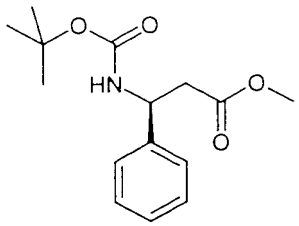
A solution of *tert*-butyl (3S)-3-amino-3-phenylpropanoate (5.04g, 22.9mmol) in 2.25M methanolic hydrochloric acid (100ml) was heated under reflux for 2 hours. The mixture was cooled to room temperature, basified with saturated sodium carbonate solution to pH 8 and the phases separated. The aqueous layer was extracted with dichloromethane (4x), the combined organic solutions were washed with brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure to afford the title compound 3.97g.

^{1}H-NMR (400MHz, $CDCl_3$) : δ [ppm] 1.70 (2H, s), 2.66 (2H, d), 3.68 (3H, s), 4.43 (1H, t), 7.25-7.40 (5H, m)

LRMS: m/z 180.3 (MH^+).

PREPARATION 5

Methyl (3S)-3-[(*tert*-butoxycarbonyl)amino]-3-phenylpropanoate



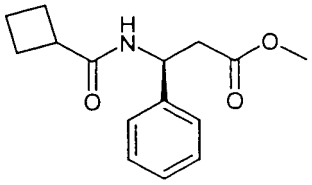
The title compound from preparation 4 (5.38g, 30mmol) and di-*tert*-butyl dicarbonate (8.72g, 40mmol) in tetrahydrofuran (50ml) and 2N sodium hydroxide solution (25ml) were stirred at room temperature for 2 hours. The reaction mixture was diluted with ethyl acetate, the layers separated and the aqueous phase extracted with ethyl acetate (2x). The combined organic solutions were washed with water, brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure to afford the title compound as a white solid, 8.39g.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.41(9H, s), 2.84 (2H, m), 3.61 (3H, s), 5.10 (1H, bs), 5.41 (1H, bs), 7.22-7.36 (5H, m)

LRMS: m/z 279.7 (MH^+)

PREPARATION 6

Methyl (3*S*)-3-[(cyclobutylcarbonyl)amino]-3-phenylpropanoate

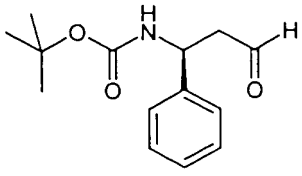


Obtained from the title compound of preparation 4 and cyclobutanecarbonyl chloride as a brown solid in 82% yield using a similar procedure to that in preparation 2.

^{1}H-NMR (300MHz, $CDCl_3$) : δ [ppm] 1.81-2.06 (2H, m), 2.10-2.40 (5H, m), 2.82-3.08 (2H, m), 3.62 (3H, s), 5.42 (1H, m), 6.42 (1H, d), 7.22-7.38 (5H, m)

PREPARATION 7

tert-Butyl (1*S*)-3-oxo-1-phenylpropylcarbamate



Diisobutylaluminium hydride (1M in dichloromethane, 60ml, 60mmol) was cooled to -78°C and added dropwise to a solution of the title compound from preparation 5 (8.39g, 30mmol) in dichloromethane (150ml) at -78°C. The reaction was stirred for 90 minutes, then

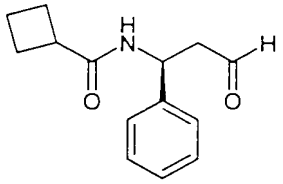
methanol (pre-cooled to -78°C) (40ml) was added. The mixture was allowed to warm to room temperature and poured into 2M hydrochloric acid (200ml). The layers were separated and the aqueous phase extracted with dichloromethane (2x). The combined organic layers were dried ($MgSO_4$), filtered and evaporated under reduced pressure to afford the title compound as a white solid, 6.72g.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.42 (9H, s), 2.86-3.00 (2H, m), 5.06 (1H, bs), 5.20 (1H, bs), 7.22-7.38 (5H, m), 9.75 (1H, s)

LRMS: m/z 250.1 (MH^+)

PREPARATION 8

N-[(1*S*)-3-Oxo-1-phenylpropyl]cyclobutanecarboxamide

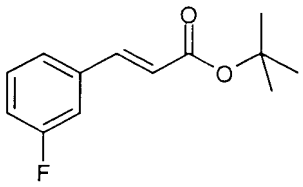


Obtained from the title compound of preparation 6 as a brown oil in 82% yield using a similar procedure to that in preparation 7.

^{1}H-NMR (300MHz, $CDCl_3$) : δ [ppm] 1.81-2.35 (6H, m), 2.90-3.10 (3H, m), 5.53 (1H, m), 5.98 (1H, br d), 7.23-7.39 (5H, m), 9.78 (1H, m)

PREPARATION 9

tert-Butyl (*E*)-3-(3-fluorophenyl)-2-propenoate

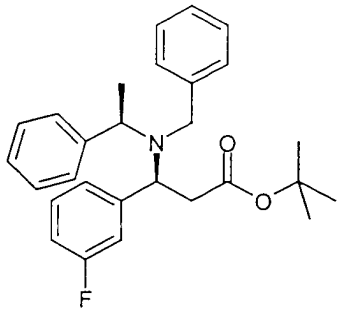


To a solution of 3-fluorobenzaldehyde (10.0g, 80mmol) in tetrahydrofuran (350ml) was added *tert*-butyl-2-(triphenylphosphoranylidene)acetate (27.6g, 73mmol) in 1g portions over 30 minutes. Upon the final addition, the mixture was heated under reflux for 10 minutes. The solvent was removed under reduced pressure and the solid residue was triturated with pentane (x2). The pentane extracts were combined and evaporated under reduced pressure. The residue was purified by filtration though a plug of silica gel using diethyl ether:hexane (1:2) as eluant to afford the title compound as a colourless oil, 16.2g.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.52 (9H, s), 6.32-6.39 (1H, d), 7.00-7.06 (1H, m), 7.16-7.21 (1H, m), 7.26-7.29 (1H, m), 7.29-7.37 (1H, m), 7.48-7.55 (1H, d)

PREPARATION 10

tert-Butyl (3*S*)-3-{benzyl[(1*R*)-1-phenylethyl]amino}-3-(3-fluorophenyl)propanoate



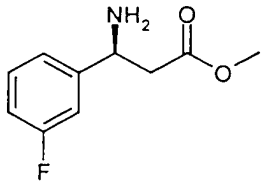
To a solution of (1*R*)-*N*-benzyl-1-phenyl-1-ethanamine (23.1g, 109mmol) in tetrahydrofuran (100ml) at -10 °C was added n-butyl lithium (66ml of a 1.6M solution in hexane, 105mmol) dropwise. The purple solution was stirred for 15 minutes, cooled to -78 °C and a solution of the title compound of preparation 9 (18.6g, 84mmol) in tetrahydrofuran (100ml) added dropwise. After stirring for 30 minutes the mixture was quenched with saturated ammonium chloride solution (100ml) and stirred to room temperature. The mixture was extracted with diethyl ether (x2) and the combined organic layers were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was dissolved in diethyl ether and washed with 1M citric acid (x2) then water, dried ($MgSO_4$), filtered and evaporated under reduced pressure. The pale yellow oily residue was purified by column chromatography on silica gel using a gradient elution of diethyl ether:hexane (0:100 to 5:95) to afford the title compound as a colourless oil, 23.0g.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.19-1.32 (3H, m), 1.23 (9H, s), 2.42-2.52 (2H, m), 3.68 (2H, s), 3.90-4.00 (1H, m), 4.35-4.42 (1H, m), 6.89-6.97 (1H, m), 7.10-7.35 (11H, m), 7.35-7.42 (2H, m)

LRMS: m/z 434.5 (MH^+)

PREPARATION 11

Methyl (3*S*)-3-amino-3-(3-fluorophenyl)propanoate



A mixture of the title compound of preparation 10 (23.0g, 53mmol), ammonium formate (33.5g, 531mmol) and 20% palladium hydroxide on carbon (12.5g) were heated under reflux in ethanol for 30 minutes (500ml). The reaction was cooled and filtered through Arbocel® and the filtrate evaporated under reduced pressure. The residue (16.3g, 68mmol)

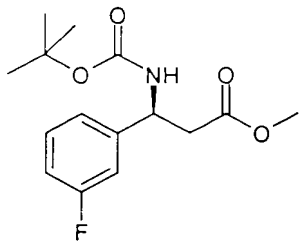
was heated under reflux for 1 hour in methanolic hydrochloric acid (100ml, 2.25M). The mixture was evaporated under reduced pressure and the resulting solid triturated with ethyl acetate to afford the title compound as a white solid, 4.40g.

^{1}H NMR (400 MHz, CD_3OD): δ [ppm] 3.00-3.16 (2H, m), 3.71 (3H, s), 4.74-4.81 (1H, m), 7.13-7.23 (1H, m), 7.24-7.34 (2H, m), 7.44-7.53 (1H, m)

LRMS: m/z 198.2 (MH^+)

PREPARATION 12

Methyl (3*S*)-3-[(*tert*-butoxycarbonyl)amino]-3-(3-fluorophenyl)propanoate

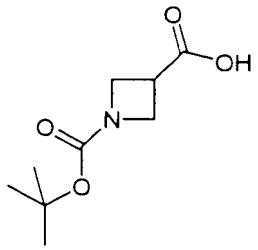


To a suspension of the title compound of preparation 11 (3.81g, 16.3mmol) in tetrahydrofuran (50ml) was added di-*tert*-butyl dicarbonate (4.26g, 19.5mmol) and 2M aqueous sodium hydroxide (20ml). The mixture was stirred for 16 hours at room temperature. The mixture was diluted with water and extracted with diethyl ether (x3), the combined organic solutions were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by recrystallisation from hexane to afford the title compound as a white solid, 4.10g.

^{1}H NMR (400 MHz, $CHCl_3$): δ [ppm] 1.40 (9H, s), 2.76-2.89 (2H, m), 3.63 (3H, m), 5.01-5.13 (1H, m), 5.42-5.65 (1H, bs), 6.90-6.97 (1H, m), 6.97-7.02 (1H, m), 7.03-7.10 (1H, m), 7.26-7.32 (1H, m)

PREPARATION 13

1-(*tert*-Butoxycarbonyl)-3-azetidinecarboxylic acid



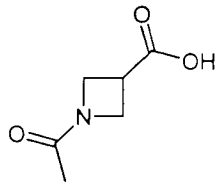
Di-*tert*-butyl dicarbonate (3.02g, 13.8mmol) was added to a suspension of 3-azetidine carboxylic acid (1.00g, 10.0mmol) and potassium carbonate (1.80g, 13.0mmol) in water (18ml) and dioxane (18ml) at 0°C and allowed to warm to room temperature. The reaction

was stirred for 15 hours and concentrated under reduced pressure. The residue was acidified to pH 4 by the addition of 1M citric acid solution and extracted with dichloromethane (x3). The combined organic solutions were washed with water and brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure to afford the title compound as a white solid, 2.10g.

^1H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.44 (9H, s), 3.38 (1H, m), 4.14 (4H, d)

PREPARATION 14

1-Acetyl-3-azetidinecarboxylic acid



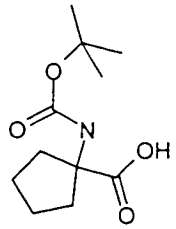
3-Azetidine carboxylic acid (2.25g, 22.2mmol) and acetic anhydride (80ml) were heated gently until all of the acid had dissolved. The reaction was stirred at room temperature for 18 hours and then the acetic anhydride was removed under reduced pressure. Water was added and evaporated under reduced pressure. The residue was dissolved in hot ethyl acetate and filtered whilst hot and the filtrate was evaporated under reduced pressure to afford the title compound as a white solid, 1.54g.

^1H NMR (400MHz, CD_3OD): δ [ppm] 1.84 (3H, s), 3.37-3.50 (1H, m), 4.00-4.09 (1H, m), 4.12-4.18 (1H, m), 4.23-4.41 (2H, m)

LRMS: m/z 142.1 (MH^+)

PREPARATION 15

1-[(*tert*-Butoxycarbonyl)amino]cyclopentanecarboxylic acid

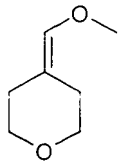


1-Aminocyclopentanecarboxylic acid (1.00g, 7.74mmol), di-*tert*-butyl dicarbonate (3.85g, 17.6mmol) and potassium carbonate (2.28g, 16.5mmol) were stirred together for 16 hours at room temperature in dioxane (20ml) and water (20ml). The solvents were removed under reduced pressure and the residue acidified with 1M citric acid solution and extracted with dichloromethane (x3). The organic solutions were dried ($MgSO_4$), filtered and evaporated under reduced pressure to yield an oil which crystallized on standing, this was triturated with hexane to afford the title compound as a white solid, 1.26g.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.4 (9H, s), 1.74-1.81 (4H, m), 1.85-1.97 (2H, m), 2.20-2.32 (2H, m).

PREPARATION 16

4-(Methoxymethylene)tetrahydro-2*H*-pyran



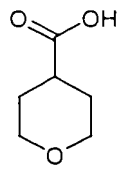
Tetrahydro-4H-pyran-4-one (5.00g, 50mmol) was dissolved in tetrahydrofuran (250 ml) and cooled in an ice-water bath. To this solution was added n-butyl lithium (24ml of a 2.5M solution in hexane, 60 mmol) and the reaction mixture was then allowed to warm to room temperature and stirred for 1 hour. This was then cooled to 0°C and a solution of (methoxymethyl)triphenyl phosphonium chloride (25.6g, 75mmol) in tetrahydrofuran (10 ml) was added and the reaction stirred for 30 minutes. The reaction mixture was then concentrated under reduced pressure and the residue triturated with diethyl ether (10×), decanting the supernatant each time. The combined supernatants were then evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using an elution gradient of pentane:ethyl acetate (95:5 to 90:10) to provide the title compound, 1.80g.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 2.05 (2H, t), 2.30 (2H, t), 3.50 (3H, s), 3.60 (4H, m), 5.80 (1H, s).

LRMS: m/z 146 (MNH_4^+)

PREPARATION 17

Tetrahydro-2H-pyran-4-carboxylic acid



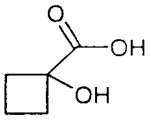
To a stirred solution of the title compound of preparation 16 (1.80g, 14.0mmol) in acetone (30 ml) was added 1M hydrochloric acid (1 ml) at room temperature and the mixture stirred for 3 hours. The solution was then diluted with additional acetone and Jones' reagent added until the solution became permanently brown. The reaction mixture was then evaporated under reduced pressure and the residue purified by column chromatography on silica gel using ethyl acetate:pentane (75:25) as eluant to afford the title compound as a white solid, 1.18 g.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.85 (4H, m), 2.55 (1H, m), 3.45 (2H, m), 3.99 (2H, m), 11.10 (1H, bs)

LRMS: m/z 129 ($M-H^-$)

PREPARATION 18

1-Hydroxycyclobutanecarboxylic acid



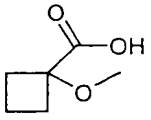
n-Butyllithium (96ml of a 2.5M solution in hexane, 240mmol) was added dropwise to a tetrahydrofuran (400ml) solution of di*iso*propylamine (34ml, 240mmol) at -78°C. The reaction was warmed to 0°C and a solution of cyclopentanecarboxylic acid (6.64g, 66mmol) in tetrahydrofuran (100ml) was added dropwise. The reaction was allowed to warm to room temperature and stirred for 6 hours. The reaction was cooled to 10°C and oxygen bubbled through for 15 minutes and stirred for 1 hour, 10% aqueous sodium sulphite was then added in one portion and the reaction warmed to room temperature. The reaction was diluted with water (200ml) and extracted with ether (5x). The combined organic solutions were dried ($MgSO_4$), filtered and evaporated under reduced pressure to afford the title compound as a white solid, 1.16 g.

^{1}H NMR (300 MHz, $CDCl_3$): δ[ppm] 1.98 (2H, m), 2.34 (2H, m), 2.56 (2H, m), 6.35 (1H, bs)

LRMS: m/z 231 ($2M-H^-$)

PREPARATION 19

1-Methoxycyclobutanecarboxylic acid

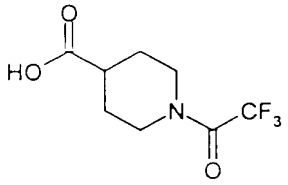


Sodium hydride (60% dispersion in oil, 1.20g, 30mmol) was added in one portion to a tetrahydrofuran (100ml) solution of the title compound of preparation 18 (1.16g, 10mmol) and iodomethane (1.86ml, 30mmol) at 0°C. The reaction was allowed to warm to room temperature and stirred for 5 days. The solvent was removed under reduced pressure and 2M hydrochloric acid (100ml) added. The aqueous mixture was extracted with diethyl ether (3x) and the combined organic solutions dried ($MgSO_4$), filtered and evaporated under reduced pressure to afford a clear oil. The oil was purified by column chromatography on silica gel using dichloromethane:methanol:acetic acid (90:10:1) as eluant to afford the title compound as an orange solid, 1.11g.

^{1}H NMR (300 MHz, $CDCl_3$): δ[ppm] 1.98 (2H, m), 2.28 (2H, m), 2.54 (2H, m), 3.38 (3H, s)

PREPARATION 20

1-(2,2,2-Trifluoroacetyl)-4-piperidinecarboxylic acid



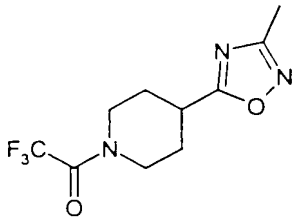
Trifluoroacetic anhydride (32.5g, 155mmol) was added dropwise to a suspension of 4-piperidinecarboxylic acid (16.7g, 130mmol) in dichloromethane (900ml) at 0°C and stirred for 12 hours. The reaction mixture was washed with water and brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure to afford the title compound as a white solid, 10.0 g.

^{1}H NMR (300 MHz, $CDCl_3$): δ[ppm] 1.80 (2H, m), 2.05 (2H, m), 2.65 (1H, m), 2.80 (1H, m), 3.10 (1H, m), 3.30 (1H, m), 3.95 (1H, m), 4.30 (1H, m)

LRMS: m/z 224 ($M-H^-$)

PREPARATION 21

2,2,2-Trifluoro-1-[4-(3-methyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-ethanone

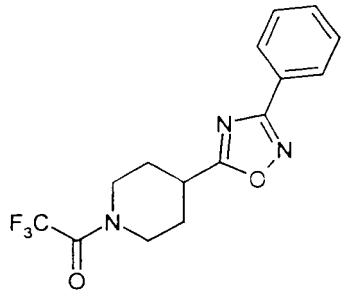


The title compound from preparation 20 (1.00g, 4.44mmol) was added to a solution of *N*-hydroxy-acetamidine (362mg, 4.88mmol) [Chem. Ber., (1884), 17, 2746] and 1-(3-dimethyl aminopropyl)-3-ethylcarbodiimide hydrochloride (1.02g, 5.33mmol) in dichloromethane (20ml) and the reaction stirred at room temperature for 18 hours. The mixture was then washed with water and brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure to afford a clear oil. This intermediate was dissolved in toluene (30ml) and heated under reflux with continuous removal of water for 18 hours. The cooled solution was evaporated under reduced pressure and the residue purified by column chromatography on silica gel using ethyl acetate:hexane (50:50) as eluant to afford the title compound as an oil, 580mg.

^{1}H-NMR (300MHz, $CDCl_3$) : δ [ppm] 1.88-2.05 (2H, m), 2.20 (2H, m), 2.40 (3H, s), 3.13-3.48 (3H, m), 4.01 (1H, d), 4.37 (1H, m)

PREPARATION 22

2,2,2-Trifluoro-1-[4-(3-phenyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-ethanone



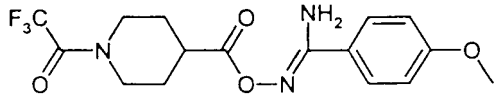
Obtained from the title compound of preparation 20 and *N'*-hydroxybenzenecarboximidamide [Tetrahedron, (1997), 53(5), 1787-1796] as a brown oil in 82% yield using a similar procedure to that in preparation 21.

^{1}H-NMR (300MHz, $CDCl_3$) : δ [ppm] 2.04 (2H, m), 2.26 (2H, m), 3.20-3.51 (3H, m), 4.08 (1H, m), 4.20 (1H, m), 7.49 (3H, m), 8.09 (2H, m)

LRMS : m/z 343 (MNH_4^+)

PREPARATION 23

1-{4-[({Amino(4-methoxyphenyl)methylidene]amino}oxy)carbonyl]-1-piperidinyl}-2,2,2-trifluoro-1-ethanone



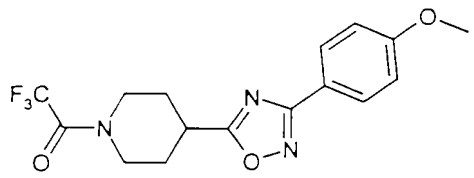
N-Methylmorpholine (0.32ml, 2.92mmol), 4-dimethylaminopyridine (81mg, 0.66mmol) and 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (306mg, 1.59mmol) were added to a suspension the title compound from preparation 20 (299mg, 1.33mmol) and N-hydroxy-4-methoxybenzamidine [Chem. Ber., (1889), 22, 2791] (268mg, 1.33mmol) in dichloromethane (20ml), and the reaction stirred at room temperature for 40 minutes. The reaction mixture was washed with 1M citric acid solution, saturated aqueous sodium bicarbonate solution, water and brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure to afford the title compound as a yellow foam, 320mg.

^{1}H-NMR (300MHz, $CDCl_3$) : δ [ppm] 1.94 (2H, m), 2.11 (2H, m), 2.88 (1H, m), 3.16 (1H, m), 3.35 (1H, m), 3.61 (3H, s), 4.02 (1H, m), 4.37 (1H, m), 4.99 (2H, s), 6.94 (2H, d), 7.64 (2H, d)

LRMS : m/z 391 (MNH_4^+)

PREPARATION 24

2,2,2-Trifluoro-1-[4-{3-(4-methoxyphenyl)-1,2,4-oxadiazol-5-yl}-1-piperidinyl]-1-ethanone



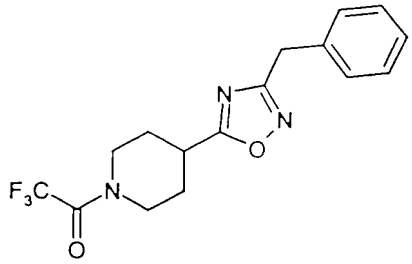
A solution of the title compound of preparation 23 (317mg, 0.85mmol) in toluene (65ml) was heated under reflux with continuous removal of water for 18 hours, and the cooled mixture concentrated under reduced pressure. The residue was purified by column chromatography on silica gel, using an elution gradient of pentane:dichloromethane:methanol:0.88 ammonia (50:50:0:0 to 0:98:1:0.3) to afford the title compound, as a clear oil, 197mg.

^{1}H-NMR (300MHz, $CDCl_3$) : δ [ppm] 1.98-2.15 (2H, m), 2.26 (2H, m), 3.22-3.52 (3H, m), 3.88 (3H, s), 4.06 (1H, m), 4.39 (1H, m), 7.00 (2H, d), 8.01 (2H, d)

LRMS : m/z 356 (MH^+)

PREPARATION 25

2,2,2-Trifluoro-1-[4-(3-Benzyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-ethanone



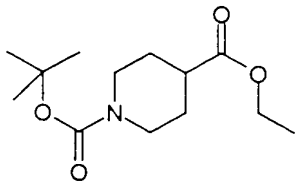
Obtained from the title compounds of preparations 20 and 56 as an oil in 11% yield using a similar procedure to that in preparation 21.

^{1}H-NMR (300MHz, $CDCl_3$) : δ [ppm] 1.81-2.02 (2H, m), 2.18 (2H, m), 3.09-3.42 (3H, m), 3.94-4.08 (3H, m), 4.36 (1H, m), 7.31 (5H, m)

LRMS : m/z 357 (MH^+)

PREPARATION 26

1-(*tert*-Butyl)-4-ethyl-1,4-piperidinedicarboxylate



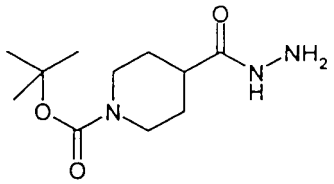
1M Sodium hydroxide solution (50ml, 50.0mmol) was added to a solution of ethyl 4-piperidinecarboxylate (10.0g, 63.6mmol) and di-*tert*-butyl dicarbonate (16.7g, 76.3mmol) in dioxane (50ml). The reaction mixture was stirred at room temperature for 3 hours, the solvent was evaporated under reduced pressure and the residue acidified with 2M hydrochloric acid. The aqueous solution was extracted with ethyl acetate (x3), the combined organic extracts were washed with brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure to afford the title compound as a colourless oil, 16.7g.

^{1}H-NMR (300MHz, $CDCl_3$) : δ [ppm] 1.23 (3H, t), 1.47 (9H, s), 1.58-1.71 (2H, m), 1.83 (2H, m), 2.45 (1H, m), 2.78-2.88 (2H, m), 4.09 (2H, m), 4.15 (2H, q)

LRMS : m/z 258 (MH^+)

PREPARATION 27

tert-Butyl 4-(hydrazinocarbonyl)-1-piperidinecarboxylate



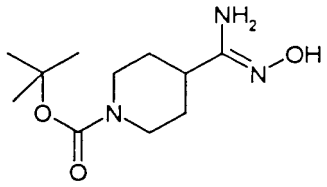
Hydrazine hydrate (5ml) was added to a solution of the title compound of preparation 26 (4.96g, 19.3mmol) in methanol (50ml) and the reaction heated under reflux for 48 hours. The cooled mixture was evaporated under reduced pressure, and the residue purified by column chromatography on silica gel using ethyl acetate:methanol (95:5) as eluant to afford the title compound as a white crystalline solid, 3.72g.

^{1}H-NMR (300MHz, $CDCl_3$) : δ [ppm] 1.40-1.58 (9H, bs), 1.60-1.85 (4H, m), 2.20-2.33 (1H, m), 2.62-2.85 (2H, m), 4.15 (2H, m)

LRMS : m/z 243 (MH^+)

PREPARATION 28

tert-Butyl 4-[amino(hydroxyimino)methyl]-1-piperidinecarboxylate



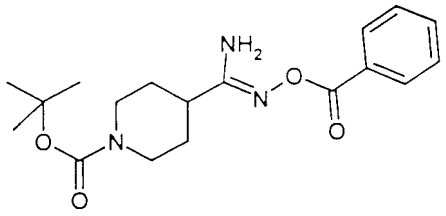
A mixture of *tert*-butyl 4-cyano-1-piperidinecarboxylate (2.69g, 12.8mmol), hydroxylamine hydrochloride (4.45g, 64mmol) and sodium carbonate (6.78g, 64mmol) in water (40ml) and methanol (40ml) was heated under reflux for 5 hours. The cooled mixture was concentrated under reduced pressure and the remaining aqueous solution extracted with

ethyl acetate (3x). The combined organic extracts were washed with water and brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure to afford the title compound as a white solid, 2.60g.

^{1}H-NMR (300MHz, $CDCl_3$) : δ [ppm] 1.38-1.62 (11H, m), 1.80 (2H, m), 2.26 (2H, m), 2.76 (2H, m), 4.16 (2H, m), 4.58 (2H, s)

PREPARATION 29

tert-Butyl 4-{amino[(benzoyloxy)imino]methyl}-1-piperidinecarboxylate

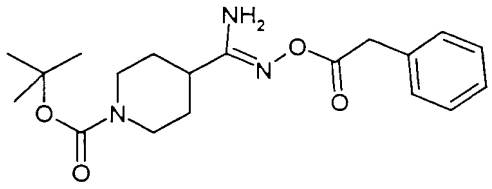


N-methylmorpholine (1.08ml, 9.86mmol), benzoic acid (1.10g, 9.04mmol), 4-dimethylaminopyridine (502mg, 4.11mmol) and 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (1.89g, 9.86mmol) were added to a solution of the title compound of preparation 28 (2.00g, 8.22mmol) in dichloromethane (100ml), and the reaction stirred at room temperature for 16 hours. The mixture was washed with 1M citric acid solution, saturated aqueous sodium bicarbonate solution, water and brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure to afford the title compound as a white foam, 1.84g.

^{1}H-NMR (300MHz, $CDCl_3$) : δ [ppm] 1.46 (9H, s), 1.57-1.72 (2H, m), 1.94 (2H, m), 2.60 (1H, m), 2.78 (2H, m), 4.23 (2H, m), 4.80 (2H, s), 7.46 (2H, m), 7.58 (1H, m), 8.02 (2H, d)

PREPARATION 30

tert-Butyl 4-(amino{[(2-phenylacetyl)oxy]imino}methyl)-1-piperidinecarboxylate

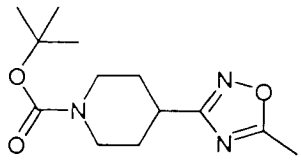


Obtained from the title compound of preparation 28 and phenylacetic acid as a white foam in 69% yield using a similar procedure to that in preparation 29.

^{1}H-NMR (300MHz, $CDCl_3$) : δ [ppm] 1.45 (9H, s), 1.55 (2H, m), 1.82 (2H, m), 2.44 (1H, m), 2.72 (2H, m), 3.78 (2H, s), 4.19 (2H, m), 4.51 (2H, s), 7.31 (5H, m)

PREPARATION 31

tert-Butyl 4-(3-methyl-1,2,4-oxadiazol-5-yl)-1-piperidinecarboxylate



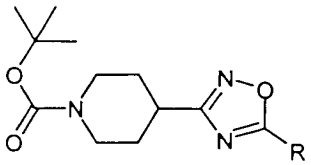
Glacial acetic acid (0.67ml, 11.7mmol), 1-(3-dimethyl aminopropyl)-3-ethylcarbodiimide hydrochloride (2.46g, 12.8mmol), 4-dimethylaminopyridine (635mg, 5.54mmol) and N-methylmorpholine (1.41ml, 12.8mmol) were added to a solution of the title compound of preparation 28 (2.60g, 10.7mmol) in dichloromethane (100ml) and the reaction stirred at room temperature for one hour. The reaction was washed with 1M citric acid solution, aqueous saturated sodium bicarbonate solution, water, dried ($MgSO_4$), filtered and evaporated under reduced pressure to give a yellow oil. A solution of this product in toluene (30ml) was heated under reflux for 24 hours, then cooled. The solution was evaporated under reduced pressure and the residue purified by column chromatography on silica gel, using ethyl acetate:pentane (50:50) as eluant to afford the title compound as a clear oil, 1.10g.

^{1}H-NMR (300MHz, $CDCl_3$) : δ [ppm] 1.47 (9H, s), 1.66-1.81 (2H, m), 1.98 (2H, m), 2.58 (3H, s), 2.92 (3H, m), 4.12 (2H, m)

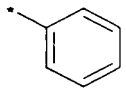
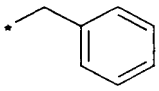
LRMS : m/z 268 $(MH)^+$

PREPARATIONS 32 to 33

The compounds of the following tabulated preparations:



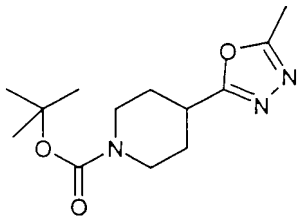
were prepared from the corresponding amidoxime esters using similar methods to that described in preparation 24.

Preparation	R	Data
32[1]		^{1}H-NMR (300MHz, $CDCl_3$) : δ [ppm] 1.49 (9H, s), 1.80-1.96 (2H, m), 2.07 (2H, m), 2.92-3.10 (3H, m), 4.18 (2H, m), 7.46-7.61 (3H, m), 8.16 (2H, d) LRMS : m/z 330 $(MH)^+$
33[1]		^{1}H-NMR (300MHz, $CDCl_3$) : δ [ppm] 1.46 (9H, s), 1.68-1.83 (2H, m), 2.00 (2H, m), 2.94 (3H, m), 4.14 (2H, m), 4.20 (2H, s), 7.18-7.38 (5H, m) LRMS : m/z 344 $(MH)^+$

1 = isolated without column chromatography

PREPARATION 34

tert-Butyl-4-(5-methyl-1,3,4-oxadiazol-2-yl)-1-piperidinecarboxylate



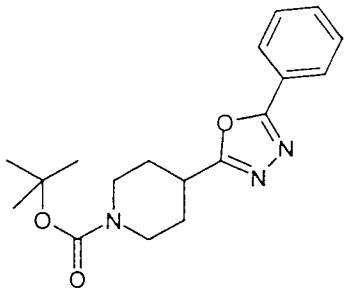
Ethyl acetimidate hydrochloride (2.35g, 19.0mmol) was added to a solution of the title compound of preparation 27 (1.83g, 7.60mmol) in ethanol (30ml). The reaction mixture was heated under reflux for 18 hours and then cooled, filtered and the filtrate evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using an elution gradient of dichloromethane:methanol:0.88 ammonia (99:1:0.1 to 95:5:0.0.5) to afford the title compound as a clear oil (1.62g).

^{1}H-NMR (300MHz, $CDCl_3$) : δ [ppm] 1.45 (9H, s), 1.70-1.85 (3H, m), 2.04 (2H, m), 2.50 (3H, s), 2.92-3.06 (2H, m), 4.08 (2H, m)

LRMS : m/z 290 (MH^+)

PREPARATION 35

tert-Butyl 4-(5-phenyl-1,3,4-oxadiazol-2-yl)-1-piperidinecarboxylate

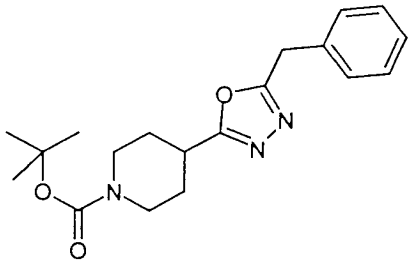


Obtained from the title compound of preparation 27 and ethylbenzimidate hydrochloride as a white solid in 69% yield using a similar procedure to that in preparation 34.

LRMS : m/z 330 (MH^+)

PREPARATION 36

tert-Butyl 4-(5-Benzyl-1,3,4-oxadiazol-2-yl)-1-piperidinecarboxylate

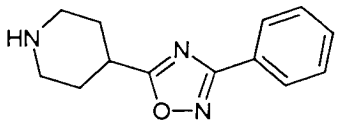


Obtained from the title compound of preparation 27 and ethyl 2-phenylacetimidate as an oil in 99% yield using a similar procedure to that in preparation 34.

^{1}H-NMR (300MHz, $CDCl_3$) : δ [ppm] 1.45 (9H, s), 1.68-1.82 (2H, m), 2.00 (2H, m), 2.84-3.06 (3H, m), 4.01-4.19 (4H, m), 7.22-7.40 (5H, m)

PREPARATION 37

4-(3-Phenyl-1,2,4-oxadiazol-5-yl)piperidine



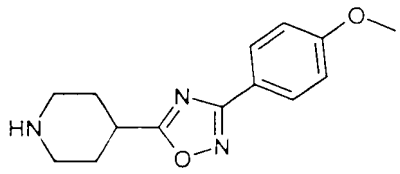
A mixture of the title compound of preparation 22, (520mg, 1.60mmol), and sodium hydroxide (96mg, 2.40mmol) in ethanol (10ml) was stirred at room temperature for 2 hours. The reaction was evaporated under reduced pressure and the residue triturated with ethyl acetate and dichloromethane. The suspension was filtered, and the filtrate evaporated under reduced pressure to afford the title compound as a white solid, 340mg.

^{1}H-NMR (300MHz, CD_3OD) : δ [ppm] 1.78-1.92 (3H, m), 2.13 (2H, m), 2.77 (2H, t), 3.02-3.35 (3H, m), 7.48 (3H, m), 8.04 (2H, m)

LRMS : m/z 230 (MH^+)

PREPARATION 38

4-{3-(4-Methoxyphenyl)-1,2,4-oxadiazol-5-yl}piperidine

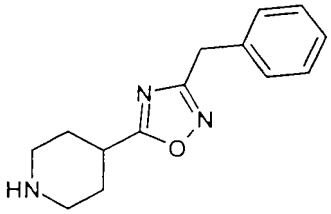


Obtained from the title compound of preparation 24 in quantitative yield using a similar procedure to that in preparation 37, except the product was isolated without trituration.

LRMS : m/z 260 (MH^+)

PREPARATION 39

4-(3-Benzyl-1,2,4-oxadiazol-5-yl)piperidine



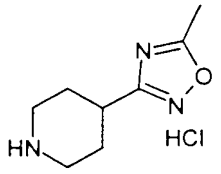
Obtained from the title compound of preparation 25 as an oil in 99% yield using a similar procedure to that in preparation 37.

^1H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.80 (2H, m), 2.05 (2H, m), 2.75 (2H, m), 3.05 (1H, m), 3.15 (2H, m), 4.05 (2H, s), 7.35 (5H, m)

LRMS : m/z 244 (MH^+)

PREPARATION 40

4-(5-Methyl-1,2,4-oxadiazol-3-yl)piperidine hydrochloride



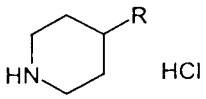
Hydrogen chloride gas was bubbled through an ice-cold solution of the title compound of preparation 31 (1.10g, 4.12mmol) in dichloromethane (30ml) for 30 minutes. The reaction mixture was evaporated under reduced pressure and the resulting solid triturated with ether. The solid was filtered and dried to afford the title compound as a white solid, 670mg.

^{1}H-NMR (300MHz, CD_3OD) : δ [ppm] 1.95-2.08 (2H, m), 2.25 (2H, m), 2.58 (3H, s), 3.19 (3H, m), 3.44 (2H, m)

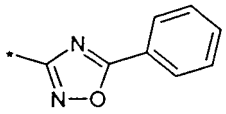
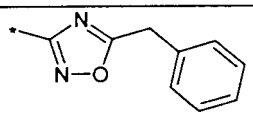
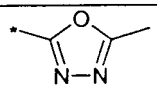
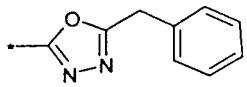
LRMS : m/z 168 (MH^+)

PREPARATIONS 41 to 44

The compounds of the following tabulated preparations:

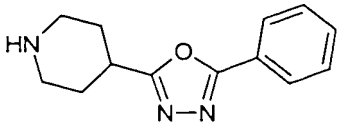


were prepared from the corresponding *tert*-butyl piperidinecarboxylates, using similar methods to that described in preparation 40.

Preparation	R	Data
1		^{1}H-NMR (300MHz, CD_3OD) : δ [ppm] 2.03-2.19 (2H, m), 2.35 (2H, m), 3.15-3.29 (4H, m), 3.52 (2H, m), 7.55-7.71 (3H, m), 8.14 (2H, m) LRMS : m/z 230 (MH^+)
2		^{1}H-NMR (300MHz, CD_3OD) : δ [ppm] 1.92-2.10 (2H, m), 2.28 (2H, m), 3.09-3.30 (3H, m), 3.44 (3H, m), 4.24 (2H, s), 7.22-7.39 (5H,m) LRMS : m/z 244 (MH^+)
3		LRMS : m/z 168 (MH^+)
4		^{1}H-NMR (300MHz, CD_3OD) : 1.87-2.17 (3H, m), 2.34 (1H, m), 3.01-3.23 (2H, m), 3.31-3.50 (4H, m), 3.64 (1H, m), 4.25 (1H, s), 7.29 (5H, m)

PREPARATION 45

4-(5-Phenyl-1,3,4-oxadiazol-2-yl)piperidine



The title compound was prepared by a similar method to preparation 40 from the title compound of preparation 35. The crude product was basified with 0.88 ammonia and purified

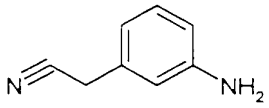
by column chromatography on silica gel using a solvent gradient of dichloromethane:methanol:0.88 ammonia (95:5:1 to 90:10:1) to afford the title compound as an oil, 300mg.

^{1}H-NMR (300MHz, $CDCl_3$) : δ [ppm] 1.66-1.95 (3H, m), 2.47 (2H, d), 2.78 (2H, t), 3.02-3.24 (3H, m), 7.43 (3H, m), 8.00 (2H, m)

LRMS : m/z 230 (MH^+)

PREPARATION 46

2-(3-Aminophenyl)acetonitrile



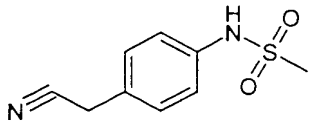
3-Nitrophenylacetonitrile (6.87g, 42mmol) and tin(II)chloride dihydrate (50g, 220mmol) in ethyl acetate (125ml) were stirred at room temperature for 72 hours. The reaction was diluted with ethyl acetate and saturated aqueous sodium bicarbonate solution was added. The resulting precipitate was filtered off and the filtrate extracted with ethyl acetate (3x). The combined organic solutions were dried ($MgSO_4$), filtered and evaporated under reduced pressure to afford the title compound as a pale yellow oil, 5.33g.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 3.59 (2H, s), 3.78 (2H, bs), 6.57-6.63 (3H, m), 7.09-7.15 (1H, m)

LRMS: m/z 132 (MH^+)

PREPARATION 47

N-[4-(Cyanomethyl)phenyl]methanesulphonamide



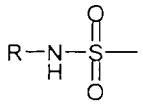
Methanesulphonyl chloride (3.22ml, 41.6mmol) was added dropwise to a solution of 4-aminobenzylcyanide (5.00g, 37.8mmol) and triethylamine (5.79ml, 41.6mmol) in dichloromethane (30ml). The reaction mixture was stirred for 1 hour and then poured onto water, the organic layer was separated, dried ($MgSO_4$), filtered and the solvent removed under reduced pressure to afford the title compound as a pale orange solid, 6.50g.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 3.05 (3H, s), 3.79 (2H, s), 6.60 (1H, s), 7.21 (2H, d), 7.35 (2H, d)

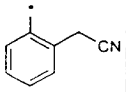
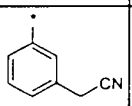
LRMS: m/z 228 (MNH_4^+)

PREPARATIONS 48 to 49

The compounds of the following tabulated preparations:

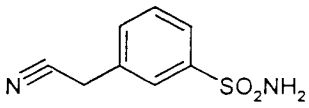


were prepared from the corresponding anilines, using similar methods to that described in preparation 47

PREPARATION	R	YIELD	DATA
48		88%	^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 3.08 (3H, s), 3.99 (2H, s), 6.30 (1H, s), 7.31 (3H, m), 7.55 (1H, dd) LRMS: m/z 228 (MNH_4^+)
49		84%	^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 3.10 (3H, s), 3.71 (2H, s), 7.10-7.18 (1H, m), 7.21 (1H, s), 7.32-7.40 (3H, m) LRMS: m/z 228.2 (MNH_4^+)

PREPARATION 50

3-(Cyanomethyl)benzenesulfonamide



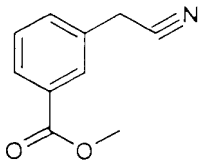
A solution of the title compound of preparation 46 (5.00g, 37.8mmol) in concentrated hydrochloric acid (13ml) and glacial acetic acid (38ml) was cooled to 0°C and sodium nitrite (2.80g, 40.5mmol) in water (4ml) was added dropwise. Once the addition was complete a suspension of copper(I)chloride (1.50g, 15.0mmol) and sulphur dioxide (10.0g) in glacial acetic acid (30ml) was added and the reaction stirred for 1 hour at 0°C. The reaction was poured onto ice and the yellow solid collected by filtration, dissolved in 0.88 ammonia (30ml) and stirred for 1 hour. The title compound was collected by filtration as a yellow solid and dried under vacuum, 5.80g.

^{1}H NMR (300 MHz, $DMSOd_6$): δ [ppm] 4.18 (2H, s), 7.34 (2H, br s), 7.58 (2H, m), 7.78 (2H, m)

LRMS: m/z 214 (MNH_4^+)

PREPARATION 51

Methyl-3-(cyanomethyl)benzoate



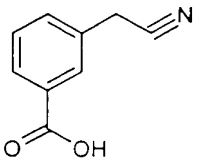
1,1,3,3-Tetramethylguanidine (3.21ml, 25.6mmol) was added dropwise to a solution of methyl 3-bromomethylbenzoate (2.80g, 12.2mmol) and acetone cyanohydrin (1.59ml, 18.3mmol) in acetonitrile (40ml) at room temperature. The reaction was stirred for 3 days and the solvent then removed under reduced pressure. The resulting brown oil was purified by column chromatography on silica gel using ethyl acetate:pentane (50:50) as eluant to afford the title compound as a clear oil, 1.80g.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 3.79 (2H, s), 3.93 (3H, s), 7.48 (1H, dd), 7.58 (1H, d), 8.02 (2H, m)

LRMS: m/z 198 (MNa^+)

PREPARATION 52

3-(Cyanomethyl)benzoic acid



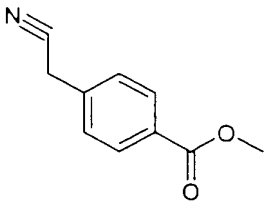
Sodium hydroxide (822mg, 20.6mmol) was added in one portion to a solution of the title compound of preparation 51 (1.80g, 10.3mmol) in tetrahydrofuran (6ml) and water (2ml) at room temperature. The reaction was stirred for 5 hours and then poured onto 2M hydrochloric acid (20ml) and the aqueous extracted with dichloromethane (3x). The combined organic extracts were dried ($MgSO_4$), filtered and the solvent evaporated under reduced pressure to give the title compound as a white solid, 1.45g.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 3.79 (2H, s), 7.48 (1H, dd), 7.61 (1H, d), 8.03 (2H, m)

LRMS: m/z 160 ($M\text{-}H^-$)

PREPARATION 53

Methyl-4-(cyanomethyl)benzoate

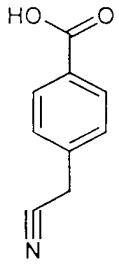


Obtained from methyl 4-(bromomethyl)benzoate as a yellow solid in 77% yield using a similar procedure to that in preparation 51.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 3.80 (2H, s), 3.93 (3H, s), 7.20 (2H, d), 8.17 (2H, d)

PREPARATION 54

4-(Cyanomethyl)benzoic acid



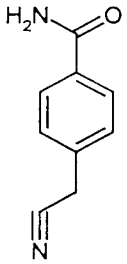
Obtained from the title compound of preparation 53 as a yellow solid in 97% yield using a similar procedure to that in preparation 52.

^{1}H NMR (400MHz, CD_3OD): δ [ppm] 3.98 (2H, s), 7.49 (2H, d), 8.02 (2H, d)

LRMS: m/z 160.0 (MH^-)

PREPARATION 55

4-(Cyanomethyl)benzamide



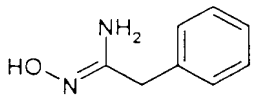
The title compound of preparation 54 (9.66g, 60mmol), was dissolved in dichloromethane (250ml) and cooled to 0°C. Oxalyl chloride (5.34ml, 61mmol), was added followed by the dropwise addition of *N,N*-dimethylformamide (0.25ml). The reaction was stirred at room temperature for 2 hours and then evaporated under reduced pressure to afford a yellow solid. This residue was dissolved in tetrahydrofuran (100ml) and 0.88 ammonia (5ml) added dropwise. After stirring for a further 10 minutes the resulting precipitate was filtered off to afford the title compound as a white solid, 6.74g.

^{1}H NMR (400MHz, CD_3OD): δ [ppm] 3.97 (2H, s), 7.48 (2H, d), 7.89 (2H, d)

LRMS: m/z 161.1 (MH^+)

PREPARATION 56

N-Hydroxy-2-phenylethanimidamide



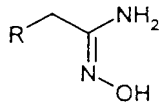
Phenyl acetonitrile (20g, 170mmol), hydroxylamine hydrochloride (60g, 850mmol) and sodium carbonate (71g, 850mmol) were heated under reflux in methanol (300 ml) and water (300 ml) for 5 hours. The reaction mixture was cooled to room temperature, filtered and the filtrate was evaporated and extracted with dichloromethane (3×). The combined organic solutions were washed with water and brine, dried ($MgSO_4$), filtered and concentrated under reduced pressure to give the title compound as a white solid, 15.5g.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 3.70 (2H, s), 7.30 (5H, m)

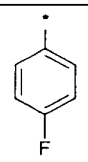
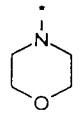
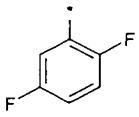
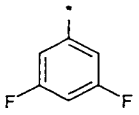
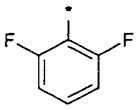
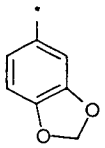
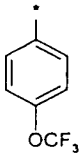
LRMS: m/z 151 (MH^+)

PREPARATIONS 57 to 63

The compounds of the following tabulated preparations:

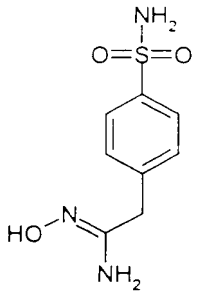


were prepared from the corresponding commercial nitriles, using similar methods to that described in preparation 56.

PREPARATION	R	YIELD	DATA
57		90%	^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 3.43 (2H, s), 4.47 (2H, s), 7.01 (2H, m), 7.24 (2H, m) 8.14 (1H, s) LRMS: m/z 169.0 (MH^+)
58		48%	^{1}H NMR (300 MHz, $DMSOd_6$): δ [ppm] 2.30 (4H, m), 2.80 (2H, s), 3.55 (4H, m), 5.2 (2H, bs), 8.95 (1H, s)
59		91%	^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.60 (1H, s), 3.46 (2H, s), 4.56 (2H, s), 6.80-7.18 (3H, m) LRMS: m/z 187.2 (MH^+)
60		61%	^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.60 (1H, s), 3.42 (2H, s), 4.46 (2H, s), 6.80 (2H, m), 7.10-7.30 (1H, m) LRMS: m/z 187.3 (MH^+)
61		58%	^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.66 (1H, s), 3.54 (2H, s), 4.60 (2H, s), 6.90 (2H, m), 7.10 (1H, m) LRMS: m/z 187.2 (MH^+)
62		36%	^{1}H NMR (400MHz, $DMSOd_6$): δ [ppm] 3.12 (2H, s), 5.32 (2H, s), 5.94 (2H, s), 6.71 (1H, d), 6.75-6.85 (2H, m), 8.85 (1H, s) LRMS: m/z 195.0 (MH^+)
63		68%	^{1}H NMR (400MHz, CD_3OD): δ [ppm] 3.40 (2H, s), 7.20 (2H, m), 7.40 (2H, m) LRMS: m/z 235.1 (MH^+)

PREPARATION 64

2-[4-(Aminosulphonyl)phenyl]-*N'*-hydroxyethanimidamide



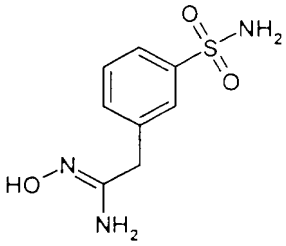
Obtained from 4-(cyanomethyl)benzenesulphonamide [J. Med. Chem., (1965), 8, 548] and hydroxylamine hydrochloride as a solid in 7% yield using a similar procedure to that in preparation 56.

^{1}H NMR (400 MHz, CD_3OD): δ [ppm] 3.42 (2H, s), 3.60 (1H, s), 7.46 (2H, m), 7.81 (2H, d)

LRMS: m/z 230 (MH^+)

PREPARATION 65

2-[3-(Aminosulphonyl)phenyl]-*N'*-hydroxyethanimidamide



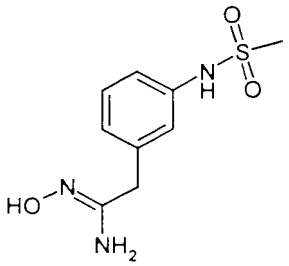
Obtained from the title compound of preparation 50 and hydroxylamine hydrochloride as a solid in 52% yield using a similar procedure to that in preparation 56.

^{1}H NMR (300 MHz, $DMSOd_6$): δ [ppm] 5.43 (2H, s), 7.21 (2H, s), 7.45 (2H, m), 7.62 (1H, m), 7.71 (1H, s), 8.95 (1H, s)

LRMS: m/z 230 (MH^+)

PREPARATION 66

N'-Hydroxy-2-{3-[(methylsulphonyl)amino]phenyl}ethanimidamide



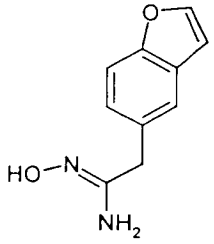
Obtained from the title compound of preparation 49 and hydroxylamine hydrochloride as a solid in 21% yield using a similar procedure to that in preparation 56.

^{1}H NMR (400 MHz, CD_3OD): δ [ppm] 2.93 (3H, s), 3.38 (2H, s), 7.03-7.12 (2H, m), 7.19 (1H, s), 7.30 (1H, m)

LRMS: m/z 243.9 (MH^+)

PREPARATION 67

2-(1-Benzofuran-5-yl)-*N*'-hydroxyethanimidamide



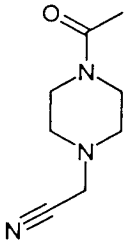
Obtained from 2-(1-benzofuran-5-yl)acetonitrile [Chim. Ther. (1972), 7(4), 337] and hydroxylamine hydrochloride as a solid in 31% yield using a similar procedure to that in preparation 56.

^{1}H NMR (400MHz, CD_3OD): δ [ppm] 3.50(2H, s), 6.80(1H, d), 7.25(1H, d), 7.40(1H, d), 7.50(1H, s), 7.70(1H, s)

LRMS: m/z 191.2 (MH^+)

PREPARATION 68

2-(4-Acetyl-1-piperazinyl)acetonitrile

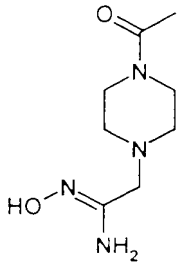


Chloroacetonitrile (14.7ml, 234mmol) was added slowly to a well stirred suspension of sodium carbonate (32g, 300mmol) and acetylpiperazine (30g, 230mmol) in toluene (200ml). The mixture was heated under reflux for 3 hours. The reaction was cooled, filtered and the filtrate evaporated under reduced pressure. The resulting solid was recrystallised from ethyl acetate to afford the title compound as a yellow solid, 18.6g.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 2.09 (3H, s), 2.58 (4H, m), 3.51 (4H, m), 3.67 (2H, m)

PREPARATION 69

2-(4-Acetyl-1-piperazinyl)-*N*'-hydroxyethanimidamide



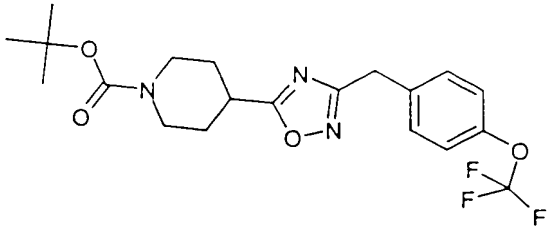
Sodium methoxide (6.6g, 67mmol) was added to the title compound of preparation 68 (18.6g, 111mmol) and hydroxylamine hydrochloride (8.5g, 122mmol) in methanol (200ml). The mixture was heated under reflux for 15 hours. The reaction was cooled to room temperature and filtered. The filtrate was evaporated under reduced pressure to afford the title compound as a white solid, 23.8g.

^{1}H NMR (400 MHz, CD_3OD): δ [ppm] 2.07 (3H, s), 2.43 (4H, m), 2.95 (2H, s), 3.59 (4H, m)

LRMS: m/z 223 (MNa^+)

PREPARATION 70

tert-Butyl 4-{3-[4-(trifluoromethoxy)benzyl]-1,2,4-oxadiazol-5-yl}-1-piperidinecarboxylate



1-(*tert*-Butoxycarbonyl)-4-piperidinecarboxylic acid (250mg, 1.09mmol) in dichloromethane (5ml) was treated with di*iso*propylethylamine (0.28ml, 2.70mmol). Bis(tetramethylene)fluoroformamidinium hexafluorophosphate (413mg, 1.31mmol) in dichloromethane (5ml) was added and the solution stirred at room temperature for 1 hour. The title compound of preparation 63 (307mg, 1.31mmol) and di*iso*propylethylamine (0.23ml, 1.09mmol) in dichloromethane (2ml) were added, the resulting solution was stirred at room temperature for 16 hours, then heated to 50°C to concentrate the solution. Dioxane (10ml) was added and the solution heated to 120°C for 3 hours. The reaction was cooled to room temperature, diluted with ethyl acetate, washed with saturated aqueous sodium bicarbonate solution and 1M citric acid solution. The combined organic solutions were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by column

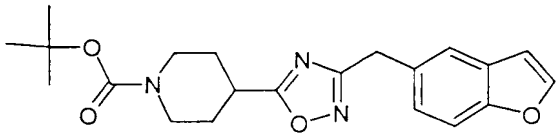
chromatography on silica gel, using ethyl acetate: pentane (25:75) as eluant to afford the title compound as an oil, 306mg.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.41 (9H, s), 1.80 (2H, m), 2.02 (2H, m), 2.94 (2H, m), 3.12 (1H, m), 4.08 (2H, s), 4.16 (2H, m), 7.15 (2H, d), 7.35 (2H, d)

LRMS: m/z 427.4 (MH^+)

PREPARATION 71

tert-Butyl 4-[3-(1-benzofuran-5-ylmethyl)-1,2,4-oxadiazol-5-yl]-1-piperidinecarboxylate



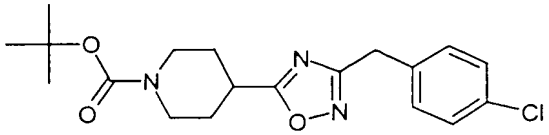
Obtained from the title compound of preparation 67 as a clear oil in 43% yield using a similar procedure to that in preparation 70.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.41 (9H, s), 1.86 (2H, m), 2.04 (2H, m), 2.95 (2H, m), 3.05 (1H, m), 4.05 (2H, bm), 4.10 (2H, s), 7.10-7.50 (5H, m)

LRMS: m/z 383.4 (MH^+)

PREPARATION 72

tert-Butyl 4-[3-(4-chlorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinecarboxylate



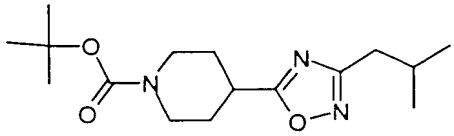
Obtained from (4-chlorophenyl)acetamidoxime [Bioorg. Med. Chem. Lett. (1996), 6(7), 833] as a clear oil in 63% yield using a similar procedure to that in preparation 70.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.45 (9H, s), 1.84 (2H, m), 2.02 (2H, m), 2.95 (2H, m), 3.05 (1H, m), 4.02 (2H, s), 4.16 (2H, m), 7.25 (4H, m)

LRMS: m/z 395.1 (MNH_4^+)

PREPARATION 73

tert-Butyl 4-(3-isobutyl-1,2,4-oxadiazol-5-yl)-1-piperidinecarboxylate



Isovaleronitrile (14.1g, 170mmol) and hydroxylamine hydrochloride (60g, 850mmol) were heated under reflux in methanol (300 ml) and water (300 ml) for 5 hours. The reaction

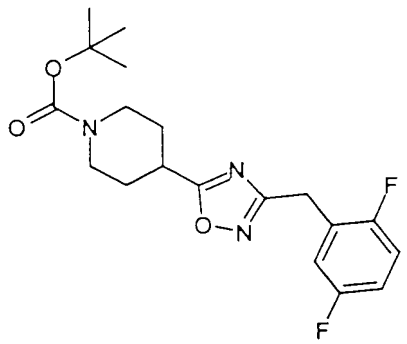
mixture was cooled to room temperature, solid sodium carbonate added cautiously and the mixture filtered. The filtrate was concentrated under reduced pressure and extracted with dichloromethane (3×). The combined organic solutions were washed with water and brine, dried ($MgSO_4$), filtered and concentrated under reduced pressure to give a white solid, 15.5g. In a separate flask 1-(*tert*-butoxycarbonyl)-4-piperidinecarboxylic acid (250mg, 1.09mmol) in dichloromethane (5ml) was treated with di*iso*propylethylamine (0.28ml, 2.70mmol). Bis(tetramethylene)fluoroformamidinium hexafluorophosphate (413mg, 1.31mmol) in dichloromethane (5ml) was added to the solution and stirred at room temperature for 1 hour. A portion of the intermediate white solid (150mg, 1.31mmol) and diisopropylethylamine (0.23ml, 1.09mmol) in dichloromethane (2ml) were added, the resulting solution was stirred at room temperature for 16 hours, then heated to 50°C to concentrate the solution. Dioxane (10ml) was added and the solution heated to 120°C for 3 hours. The reaction was cooled to room temperature, diluted with ethyl acetate, washed with saturated aqueous sodium bicarbonate solution and 1M citric acid solution. The combined organic solutions were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel, using ethyl acetate: pentane (25:75) as eluant to afford the title compound as an oil, 209mg.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 0.91 (6H, d), 1.25 (9H, s), 1.84 (2H, m), 2.05 (3H, m), 2.54 (2H, d), 2.98 (2H, m), 3.05 (1H, m), 4.07 (2H, m)

LRMS: m/z 309.9 (MH^+)

PREPARATION 74

tert-Butyl 4-{3-[2,5-difluorobenzyl]-1,2,4-oxadiazol-5-yl}-1-piperidinecarboxylate



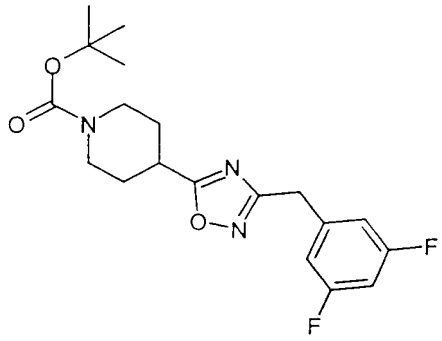
Obtained from the title compound of preparation 59 as a clear oil in 34% yield using a similar procedure to that in preparation 70.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.45 (9H, s), 1.76-1.84 (2H, m), 2.02 (2H, m), 2.94 (2H, m), 3.06 (1H, m), 4.06-4.12 (4H, m), 6.90-7.06 (3H, m)

LRMS: m/z 380.7 (MH^+)

PREPARATION 75

tert-Butyl 4-{3-[3,5-difluorobenzyl]-1,2,4-oxadiazol-5-yl}-1-piperidinecarboxylate



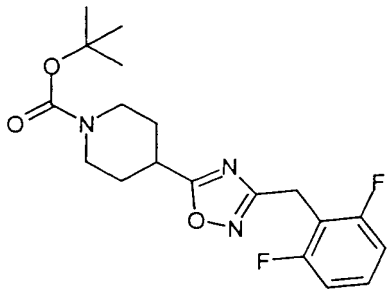
Obtained from the title compound of preparation 60 as a clear oil in 24% yield using a similar procedure to that in preparation 70.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.44 (9H, s), 1.75-1.84 (2H, m), 2.03 (2H, m), 2.96 (2H, t), 3.06 (1H, m), 4.00 (2H, s), 4.06 (2H, m), 6.70 (1H, m), 6.82 (2H, m)

LRMS: m/z 380.0 (MH^+)

PREPARATION 76

tert-Butyl 4-{3-[2,6-difluorobenzyl]-1,2,4-oxadiazol-5-yl}-1-piperidinecarboxylate



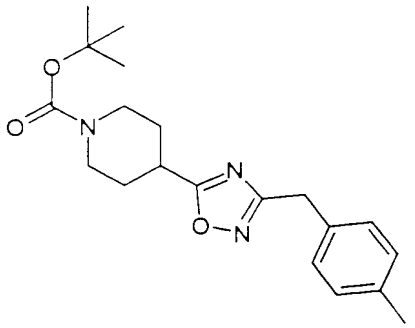
Obtained from the title compound of preparation 61 as a clear oil in 39% yield using a similar procedure to that in preparation 70.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.47 (9H, s), 1.76-1.84 (2H, m), 2.02 (2H, m), 2.94 (2H, m), 3.06 (1H, m), 4.00-4.14 (4H, m), 6.94 (2H, m), 7.23 (1H, m)

LRMS: m/z 380.0 (MH^+)

PREPARATION 77

tert-Butyl 4-{3-[4-methylbenzyl]-1,2,4-oxadiazol-5-yl}-1-piperidinecarboxylate



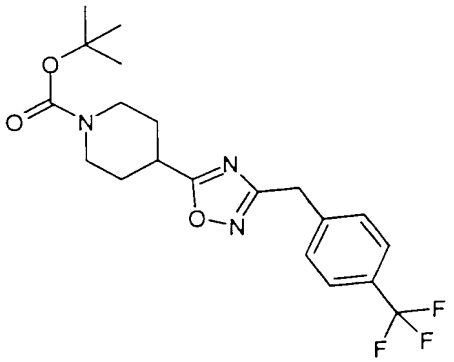
Obtained from 4-methylbenzylcyanide as an oil in 60% yield using a similar procedure to that in preparation 73.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.45 (9H, s), 1.76-1.84 (2H, m), 2.02 (2H, m), 2.34 (3H, s), 2.93 (2H, t), 3.05 (1H, m), 4.00 (2H, s), 4.05 (2H, m), 7.11 (2H, d), 7.20 (2H, d)

LRMS: m/z 358.1 (MH^+)

PREPARATION 78

tert-Butyl 4-{3-[4-trifluoromethylbenzyl]-1,2,4-oxadiazol-5-yl}-1-piperidinecarboxylate



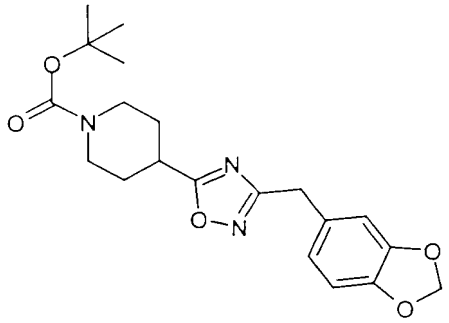
Obtained from (4-trifluoromethylphenyl)acetamidoxime [Bioorg. Med. Chem. Lett. (1996), 6(7), 833] as a clear oil in 49% yield using a similar procedure to that in preparation 70.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.44 (9H, s), 1.72-1.86 (2H, m), 2.03 (2H, m), 2.92 (2H, t), 3.03 (1H, m), 4.00-4.12 (4H, m), 7.43 (2H, d), 7.58 (2H, d)

LRMS: m/z 411.8 (MH^+)

PREPARATION 79

tert-Butyl 4-{3-[1,3-benzodioxol-5-ylmethyl]-1,2,4-oxadiazol-5-yl}-1-piperidinecarboxylate

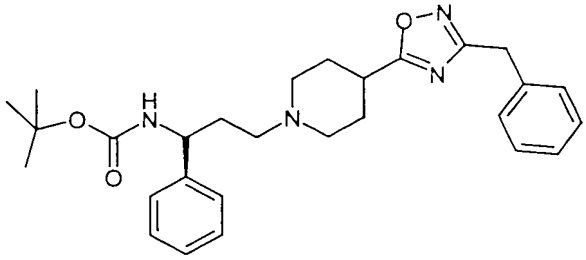


Obtained from the title compound of preparation 62 as a clear oil in 73% yield using a similar procedure to that in preparation 70.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.45 (9H, s), 1.70-1.84 (4H, m), 2.03 (2H, m), 2.93 (2H, t), 3.03 (1H, m), 3.95 (2H, s), 4.05 (2H, m), 6.70-6.82 (3H, m)

PREPARATION 80

tert-Butyl (1*S*)-3-[4-(3-benzyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropylcarbamate



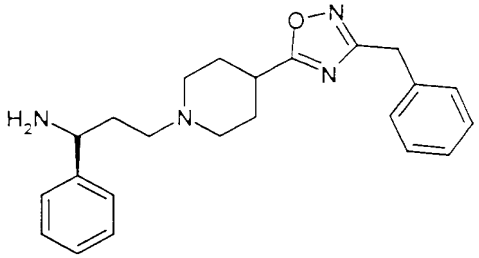
Sodium triacetoxyborohydride (1.28g, 6.02mmol) was added to a solution of the title compounds of preparation 7 (1.00g, 4.01mmol) and preparation 39 (1.07g, 4.41mmol) in dichloromethane/acetic acid (40ml, 10% solution). The reaction mixture was stirred for 30 minutes after which time the solution was basified using saturated sodium carbonate and the product was extracted with dichloromethane (x3). The combined organic extracts were dried ($MgSO_4$), filtered and the solvent evaporated under reduced pressure to give a brown oil. This was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford the title compound as an oil, 1.04g.

^{1}H NMR (400 MHz, $CDCl_3$): δ[ppm] 1.40 (9H, bs), 1.90-2.10 (7H, m), 2.30 (2H, m), 2.85 (2H, m), 2.98 (1H, m), 4.15 (2H, s), 4.80 (1H, bs), 6.50 (1H, bs), 7.30 (10H, m)

LRMS: m/z 477 (MH^+)

PREPARATION 81

(1*S*)-3-[4-(3-Benzyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropylamine



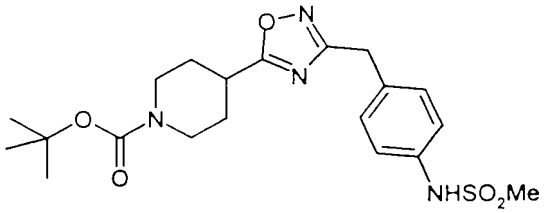
To a stirred solution of the title compound of preparation 80 (560mg, 1.17mmol) in dichloromethane (10 ml) at 0°C was added trifluoroacetic acid (5 ml). The reaction was allowed to warm to room temperature and stirred for 90 minutes. The mixture was then concentrated, basified with saturated sodium carbonate and extracted with dichloromethane (3×). The combined organic solutions were washed with brine, dried ($MgSO_4$), filtered and concentrated to give the title compound as a yellow oil, 314mg.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.90 (2H, m), 2.05 (4H, m), 2.40 (4H, m), 2.85 (2H, m), 2.95 (1H, m), 3.99 (3H, m), 4.05 (2H, s), 7.30 (10H, m)

LRMS: m/z 377 (MH^+)

PREPARATION 82

tert-Butyl-4-(3-{4-[(methylsulphonyl)amino]benzyl}-1,2,4-oxadiazol-5-yl)-1-piperidinecarboxylate



The title compound of preparation 47 (10.0g, 47mmol), hydroxylamine hydrochloride (16.5g, 238mmol) and sodium carbonate (25g, 238mmol) were heated under reflux in methanol (200 ml) and water (200 ml) for 5 hours. The reaction mixture was cooled to room temperature, filtered and the filtrate was evaporated and extracted with dichloromethane (3×). The combined organic solutions were washed with water and brine, dried ($MgSO_4$), filtered and concentrated under reduced pressure to give a white solid, 8.0g. A portion of this amidoxime (5.00g, 20.6mmol), 1-(*tert*-butoxycarbonyl)-4-piperidine carboxylic acid (5.18g, 22.6mmol) and 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (4.71g, 24.6mmol) were stirred in dichloromethane (100ml) for 2 hours. The solvent was removed under reduced pressure and the brown oil dissolved in dioxane (50ml) and heated under reflux for 5 hours. The solvent was removed under reduced pressure and the residue dissolved in ethyl acetate (200ml) washed with water and brine, dried ($MgSO_4$), filtered and concentrated

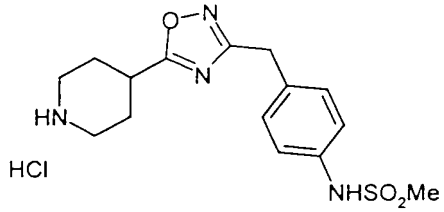
under reduced pressure. The title compound was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford the title compound as a yellow foam, 3.40g.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.41 (9H, s), 1.78 (2H, m), 2.01 (2H, m), 2.83-3.05 (5H, m), 4.03-4.19 (5H, m), 6.40 (1H, m), 7.18 (2H, d), 7.31 (2H, d)

LRMS: m/z 459 (MNa^+)

PREPARATION 83

N-(4-{[5-(4-Piperidinyl)-1,2,4-oxadiazol-3-yl]methyl}phenyl)methanesulphonamide hydrochloride



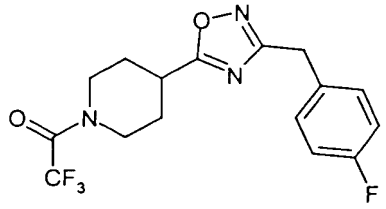
The title compound of preparation 82 (3.20g, 7.33mmol) was dissolved in methanolic hydrochloric acid (100ml, 2.5M) and stirred at room temperature for 2 hours. The solvent was removed under reduced pressure to afford the title compound as a white solid, 2.50g.

^{1}H NMR (300 MHz, D_2O): δ [ppm] 1.85 (2H, dd), 2.21 (2H, d), 2.98 (3H, s), 3.05 (2H, dd), 3.38 (4H, m), 4.00 (2H, s), 7.18 (2H, d), 7.24 (2H, d)

LRMS: m/z 337 (MH^+)

PREPARATION 84

2,2,2-Trifluoro-1-{4-[3-(4-fluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-ethanone

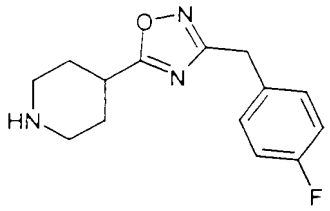


Obtained from the title compounds of preparations 20 and 57 as an oil in 15% yield using a similar procedure to that in preparation 21.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.80 (2H, m), 2.20 (2H, m), 3.15-3.40 (3H, m), 4.00 (2H, s), 7.00 (2H, m), 7.30 (2H, m)

PREPARATION 85

4-[3-(4-Fluorobenzyl)-1,2,4-oxadiazol-5-yl]piperidine



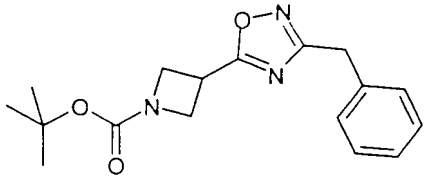
Obtained from the title compound of preparation 84 as an oil in 75% yield using a similar procedure to that in preparation 37.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.80 (2H, m), 2.10 (2H, dd), 2.80 (2H, m), 3.05 (1H, m), 3.20 (2H, m), 4.00 (2H, s), 7.00 (2H, m), 7.25 (2H, m)

LRMS: m/z 262 (MH^+)

PREPARATION 86

tert-Butyl 3-(3-benzyl-1,2,4-oxadiazol-5-yl)-1-azetidinecarboxylate



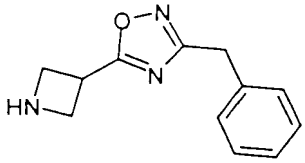
Obtained from the title compounds of preparations 13 and 56 as an oil in 72% yield using a similar procedure to that in preparation 21.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.45 (9H, s), 3.95 (1H, m), 4.08 (2H, s), 4.20 (2H, m), 4.30 (2H, t), 7.25 (1H, m), 7.35 (4H, m)

LRMS: m/z 338 (MNa^+)

PREPARATION 87

5-(3-Azetidinyl)-3-benzyl-1,2,4-oxadiazole



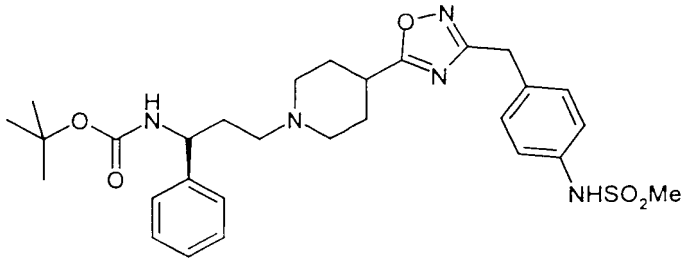
Obtained from the title compound of preparation 86 as an oil in 72% yield using a similar procedure to that in preparation 81.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 3.92 (2H, m), 4.06 (4H, m), 4.13 (1H, m), 7.25 (1H, m), 7.35 (4H, m)

LRMS: m/z 216 (MH^+)

PREPARATION 88

tert-Butyl (1*S*)-3-[4-(3-{4-[(methylsulphonyl)amino]benzyl}-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropylcarbamate



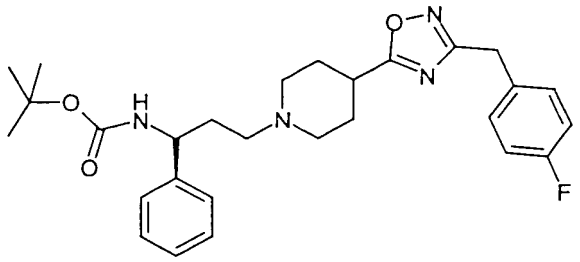
Sodium triacetoxyborohydride (1.28g, 6.02mmol) was added to a solution of the title compounds of preparation 7 (1.00g, 4.01mmol) and preparation 83 (1.65g, 4.41mmol) in dichloromethane/acetic acid (40ml, 10% solution). The reaction mixture was stirred for 30 minutes after which time the solution was basified using saturated sodium carbonate and the product was extracted with dichloromethane (x3). The combined organic extracts were dried ($MgSO_4$), filtered and the solvent evaporated under reduced pressure to give a brown oil. This was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford the title compound as a white foam, 1.30g.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.41 (9H, s), 1.80-2.19 (10H, m), 2.30 (2H, m), 2.80-3.01 (5H, m), 4.02 (2H, s), 4.75 (1H, bs), 6.38 (1H, bs), 7.15-7.40 (9H, m)

LRMS: m/z 570 (MH^+)

PREPARATION 89

tert-Butyl (1*S*)-3-{4-[3-(4-fluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropylcarbamate



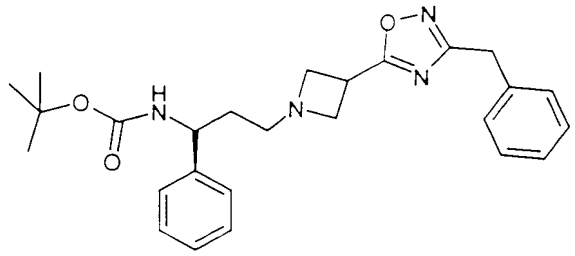
Obtained from the title compounds of preparations 7 and 85 as an oil in 81% yield using a similar procedure to that in preparation 80.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.30 (9H, bs), 1.70 (1H, m), 1.80-2.00 (4H, m), 2.20 (2H, m), 2.80 (2H, m), 2.90 (1H, m), 3.95 (2H, s), 4.70 (1H, bs), 6.60 (1H, bs), 6.90 (2H, m), 7.10 (1H, m), 7.15-7.25 (8H, m)

LRMS: m/z 495 (MH^+)

PREPARATION 90

tert-Butyl (1S)-3-[3-(3-benzyl-1,2,4-oxadiazol-5-yl)-1-azetidinyl]-1-phenylpropylcarbamate



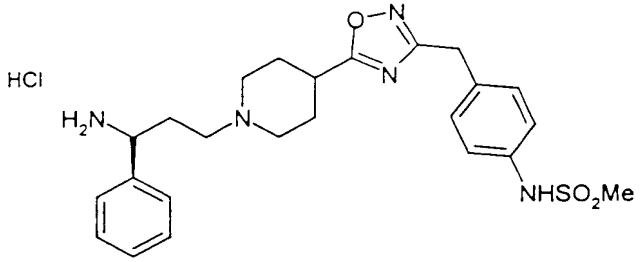
Obtained from the title compounds of preparations 7 and 87 as an oil in 64% yield using a similar procedure to that in preparation 80.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.40 (9H, bs), 1.79 (2H, m), 2.45 (2H, m), 3.31 (2H, m), 3.67 (2H, m), 3.84 (1H, m), 4.05 (2H, m), 4.3-4.5 (1H, m), 5.62 (1H, bs), 7.25 (3H, m), 7.35 (7H, m)

LRMS: m/z 449 (MH^+)

PREPARATION 91

N-{4-[(5-{1-[(3*S*)-3-Amino-3-phenylpropyl]-4-piperidinyl}-1,2,4-oxadiazol-3-yl)methyl]phenyl}methanesulfonamide hydrochloride



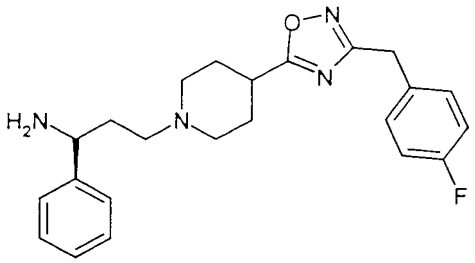
The title compound of preparation 88 (1.20g, 2.10mmol) was dissolved in methanolic hydrochloric acid (30ml, 2.5M) and stirred at room temperature for 2 hours. The solvent was removed under reduced pressure to afford the title compound as a white solid, 1.04g.

^{1}H NMR (300 MHz, D_2O): δ [ppm] 1.95 (2H, m), 2.23 (2H, m), 2.40 (2H, m), 2.71 (1H, m), 2.91-3.10 (6H, m), 3.25 (1H, m), 3.48 (2H, m), 4.03 (2H, s), 4.38 (1H, t), 7.15 (2H, d), 7.23 (2H, d), 7.40 (5H, m)

LRMS: m/z 470 (MH^+)

PREPARATION 92

(1*S*)-3-{4-[3-(4-Fluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropylamine



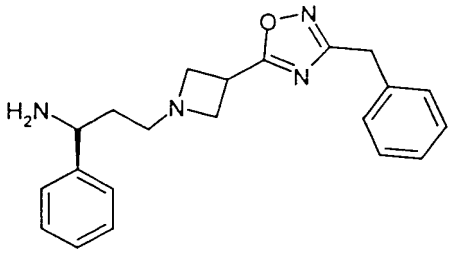
Obtained from the title compound of preparation 89 as an oil in 81% yield using a similar procedure to that in preparation 81.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.90 (4H, m), 2.05 (4H, m), 2.40 (2H, m), 2.50 (2H, bs), 2.85 (2H, m), 2.98 (1H, m), 4.00 (3H, m), 7.00 (2H, m), 7.30 (7H, m)

LRMS: m/z 395 (MH^+)

PREPARATION 93

(1S)-3-[3-(3-Benzyl-1,2,4-oxadiazol-5-yl)-1-azetidinyl]-1-phenyl-1-propanamine



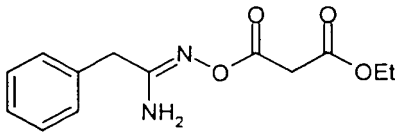
Obtained from the title compound of preparation 90 as an oil in 92% yield using a similar procedure to that in preparation 81.

^{1}H NMR (3/400 MHz, $CDCl_3$): δ [ppm] 1.60 (2H, m), 2.51 (2H, m), 3.53 (2H, t), 3.68 (2H, m), 3.87 (1H, m), 3.98 (1H, m), 4.06 (3H, m), 4.35-4.55 (1H , m), 7.2-7.36 (10H, m)

LRMS: m/z 349 (MH^+)

PREPARATION 94

Ethyl 3-({[1-amino-2-phenylethylidene]amino}oxy)-3-oxopropanoate



A solution of ethyl malonyl chloride (3.30ml, 24mmol) in dichloromethane (5ml) was added dropwise to a stirred solution of the title compound of preparation 56 (3.34g, 22mmol) and di*iso*propylethylamine (4.27ml, 24mmol) in dichloromethane (45ml) at 10°C. The reaction mixture was stirred and warmed to room temperature over 1 hour, then washed with brine, evaporated under reduced pressure and purified by column chromatography on silica gel

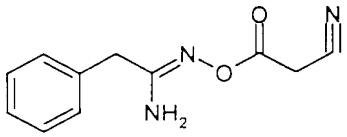
using dichloromethane:methanol (97:3) as eluant to afford the title compound as a foam, 1.15g.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.25 (3H, t), 3.48 (2H, s), 3.57 (2H, s), 4.19 (2H, q), 4.84 (2H, bs), 7.26 (5H, m)

LRMS: m/z 265 (MH^+)

PREPARATION 95

3-({[1-Amino-2-phenylethylidene]amino}oxy)-3-oxopropanenitrile



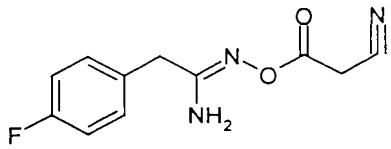
To a stirred solution of the title compound of preparation 56 (12.3g, 82mmol) in dichloromethane (100ml) was added cyanoacetic acid (6.97g, 82mmol) and 3-ethyl-1-(3-dimethylaminopropyl)-carbodiimide hydrochloride (15.7g, 82mmol). The reaction mixture was stirred for 96 hours at room temperature, then partitioned between dichloromethane and water. The organic layer was separated, washed with brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure. The resulting solid was triturated with ether to afford the title compound as a pale yellow solid, 1.71g.

^{1}H NMR (300 MHz, $CDCl_3$ + $DMSOd_6$): δ [ppm] 3.47 (2H, s), 3.59, (2H, s), 5.16 (2H, bs), 7.25 (5H, m)

LRMS: m/z 218 (MH^+)

PREPARATION 96

3-({[1-Amino-2-(4-fluorophenyl)ethylidene]amino}oxy)-3-oxopropanenitrile



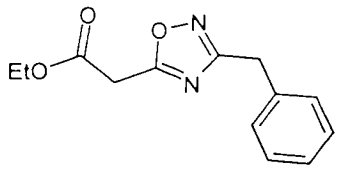
Obtained from the title compound of preparation 57 as an orange solid in 28% yield using a similar procedure to that in preparation 95.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 3.38 (2H, s), 3.57 (2H, s), 5.40 (2H, s), 6.88 (2H, m), 7.17 (2H, m)

LRMS: m/z 236.1 (MH^+)

PREPARATION 97

Ethyl 2-(3-benzyl-1,2,4-oxadiazol-5-yl)acetate



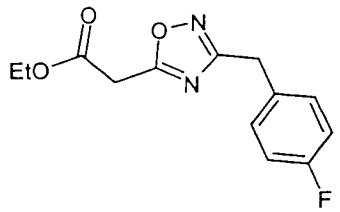
A solution of the title compound of preparation 94 (8.09g, 30mmol) in dioxane (110ml) was heated under reflux for 4 hours. The solvent was evaporated under reduced pressure and the residual oil purified by column chromatography on silica gel using dichloromethane:methanol (95:5) as eluant, to afford the title compound as an oil, 4.85g.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.24 (3H, t), 3.95 (2H, s), 4.08 (2H, s), 4.22 (2H, q), 7.26 (5H, m)

LRMS: m/z 247 (MH^+)

PREPARATION 98

Ethyl 2-[5-(4-fluorobenzyl)-1,2,4-oxadiazol-3-yl]acetate



A solution of ethyl malonyl chloride (15ml, 110mmol) in dichloromethane (50ml) was added dropwise to a stirred suspension of the title compound of preparation 57 (16.0g, 100mmol) and diisopropylethylamine (20ml, 110mmol) in dichloromethane (150ml) with ice-bath cooling. The reactants were stirred at ambient temperature overnight then washed with water and concentrated to a gum.

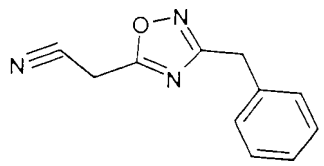
This gum was dissolved in dioxane (150ml) and heated under reflux for 12 hours. Pre-adsorption silica was added to the cooled solution which was concentrated and purified by column chromatography on silica gel using dichloromethane:methanol (95:5) as eluant to provide the title compound as an oil, 22.8g.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.26 (3H, t), 3.93 (2H, s), 4.07 (2H, s), 4.22 (2H, q), 7.00 (2H, m), 7.28 (2H, m)

LRMS: m/z 265.0 (MH^+)

PREPARATION 99

2-(3-Benzyl-1,2,4-oxadiazol-5-yl)acetonitrile

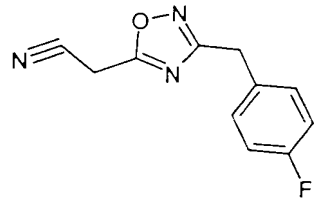


Obtained from the title compound of preparation 95 as an oil in residual dioxane using a similar procedure to that in preparation 97.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 3.70 (dioxan), 3.99 (2H, s), 4.11 (2H, s), 7.32 (5H, m)

PREPARATION 100

2-[3-(4-Fluorobenzyl)-1,2,4-oxadiazol-5-yl]acetonitrile

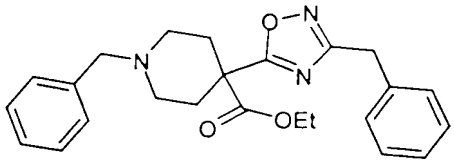


Obtained from the title compound of preparation 96 as an oil in 59% yield using a similar procedure to that in preparation 97.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 4.02 (2H, s), 4.08 (2H, s), 7.03 (2H, m), 7.28 (2H, m)

PREPARATION 101

Ethyl 1-benzyl-4-(3-benzyl-1,2,4-oxadiazol-5-yl)-4-piperidinecarboxylate



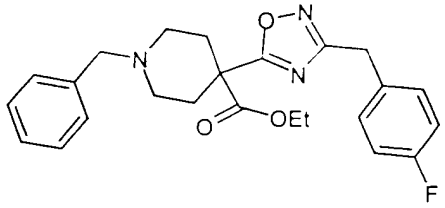
A solution of the title compound of preparation 97 (4.85g, 19.7mmol) in 1-methylpyrrolidin-2-one (10ml) was added to a stirred suspension of sodium hydride (60% dispersion in mineral oil, 2.40g, 60mmol) in 1-methylpyrrolidin-2-one (30ml). The reaction mixture was stirred for 45 minutes at room temperature before bis-(2-chloroethyl)benzylamine hydrochloride (5.00g, 18.6mmol) and tetra-n-butylammonium bromide (0.50g, 1.5mmol) were added. The reaction mixture was stirred for 24 hours at 60°C, then cooled and partitioned between ethyl acetate and water. The layers were separated and the organic phase washed with brine (3x). The organic extract was separated, pre-adsorbed on silica gel and purified by column chromatography on silica gel using dichloromethane:methanol (95:5) as eluant to provide the title compound as an oil, 4.76g.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.16 (3H, t), 2.32 (8H, m), 3.42 (2H, s), 4.08 (2H, s), 4.17 (2H, q), 7.26 (10H, m)

LRMS: m/z 406 (MH^+)

PREPARATION 102

Ethyl 1-benzyl-4-(3-benzyl-1,2,4-oxadiazol-5-yl)-4-piperidinecarboxylate



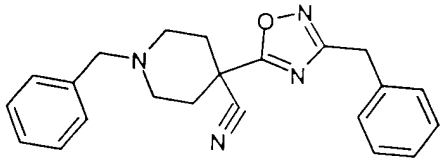
Obtained from the title compound of preparation 98 as an oil in 22% yield using a similar procedure to that in preparation 101.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.18 (3H, t), 2.32 (6H, m), 2.58 (2H, m), 3.41 (2H, s), 4.06 (2H, s), 4.15 (2H, q), 7.00 (2H, m), 7.28 (7H, m)

LRMS: m/z 424.1 (MH^+)

PREPARATION 103

1-Benzyl-4-(3-benzyl-1,2,4-oxadiazol-5-yl)-4-piperidinecarbonitrile



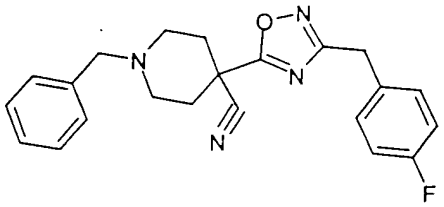
Obtained from the title compound of preparation 99 as an oil in 10% yield using a similar procedure to that in preparation 101.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 2.26 (4H, m), 2.49 (2H, m), 2.92 (2H, m), 3.56 (2H, s), 4.08 (2H, s), 7.26 (10H, m)

LRMS: m/z 359 (MH^+)

PREPARATION 104

1-Benzyl-4-[3-(4-fluorobenzyl)-1,2,4-oxadiazol-5-yl]-4-piperidinecarbonitrile



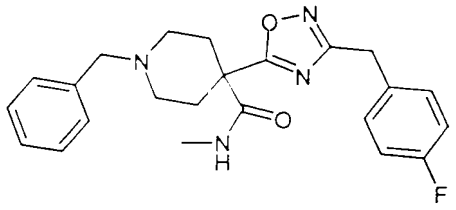
Obtained from the title compound of preparation 100 as an oil in 22% yield using a similar procedure to that in preparation 101.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 2.24 (4H, m), 2.49 (2H, m), 2.92 (2H, m), 3.57 (2H, s), 4.04 (2H, s), 6.88 (2H, t), 7.25 (7H, m)

LRMS: m/z 377.3 (MH^+)

PREPARATION 105

Ethyl 1-benzyl-4-[3-(4-fluorobenzyl)-1,2,4-oxadiazol-5-yl]-4-piperidinecarboxylate



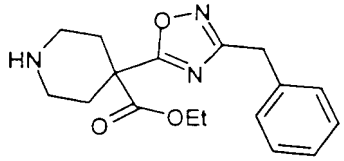
A solution of the title compound of preparation 102 (1.50g, 3.50mmol) and methylamine (20ml of a 2M solution in tetrahydrofuran, 40mmol) in ethanol (20ml) was stirred in an autoclave at 100°C for 5 hours. The solution was cooled, concentrated under reduced pressure and purified by column chromatography on silica gel using dichloromethane:methanol (95:5) as eluant, to provide the title compound as an oil, 295mg.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 2.07 (2H, m), 2.36 (4H, m), 2.73 (5H, m), 3.40 (2H, s), 4.06 (2H, s), 5.88 (1H, s), 7.00 (2H, m), 7 26 (7H, m)

LRMS: m/z 409.1 (MH^+)

PREPARATION 106

Ethyl 4-(3-benzyl-1,2,4-oxadiazol-5-yl)-4-piperidinecarboxylate



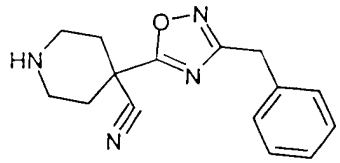
A solution of 1-chloroethylchloroformate (0.28ml, 2.6mmol) in dichloromethane (1ml) was added to a solution of the title compound of preparation 101 (820mg, 2mmol) in dichloromethane (9ml) at 0°C. The reaction mixture was stirred for 3 hours at room temperature, then the solvent evaporated and the residual oil dissolved in methanol (10ml). The solution was heated under reflux for 1 hour The solution was cooled, pre-adsorbed on silica gel, concentrated under reduced pressure and chromatographed on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant, to provide the title compound as an oil 195mg.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.18 (3H, t), 2.57 (4H, m), 3.06 (2H, m), 3.24 (2H, m), 3.46 (1H, s), 4.06 (2H, s), 4.18 (2H, q), 7.27 (5H, m)

LRMS: m/z 316 (MH^+)

PREPARATION 107

4-(3-Benzyl-1,2,4-oxadiazol-5-yl)-4-piperidinecarbonitrile



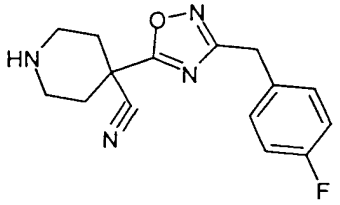
Obtained from the title compound of preparation 103 as an oil in 59% yield using a similar procedure to that in preparation 106.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 2.34 (4H, m), 3.21 (4H, m), 4.08 (2H, s), 7.26 (5H, m)

LRMS: m/z 269 (MH^+)

PREPARATION 108

4-[3-(4-Fluorobenzyl)-1,2,4-oxadiazol-5-yl]-4-piperidinecarbonitrile



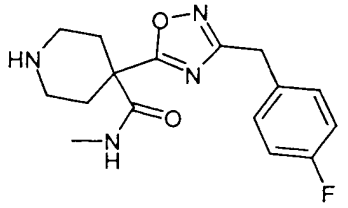
Obtained from the title compound of preparation 104 as an oil in 44% yield using a similar procedure to that in preparation 106.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 2.50 (4H, m), 3.26 (2H, m), 3.42 (2H, m), 4.06 (2H, s), 7.02 (2H, m), 7.27 (2H, m)

LRMS: m/z 287.2 (MH^+)

PREPARATION 109

4-[3-(4-Fluorobenzyl)-1,2,4-oxadiazol-5-yl]-*N*-methyl-4-piperidinecarboxamide



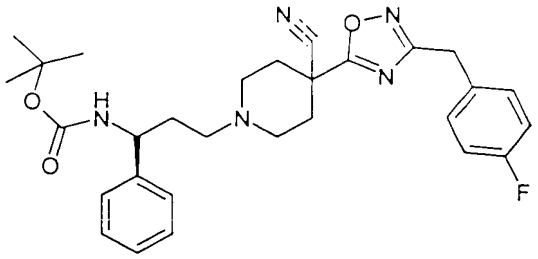
Obtained from the title compound of preparation 105 as an oil in 68% yield using a similar procedure to that in preparation 106.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 2.21 (2H, m), 2.36 (2H, m), 2.62 (2H, m), 2.74 (3H, d), 3.03 (2H, m), 4.04 (2H, s), 5.88 (1H, s), 7.00 (2H, m), 7.26 (2H, m)

LRMS: m/z 319.1 (MH^+)

PREPARATION 110

tert-Butyl (1*S*)-3-{4-cyano-4-[3-(4-fluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropylcarbamate



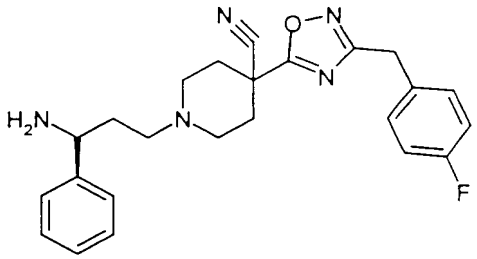
Obtained from the title compounds of preparations 7 and 108 as an oil in 54% yield using a similar procedure to that in preparation 80.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.28 (9H, s), 1.94 (2H, m), 2.38 (8H, m), 2.90 (2H, m), 4.06 (2H, s), 4.78 (1H, s), 5.85 (1H, s), 7.02 (2H, m), 7.27 (7H, m)

LRMS: m/z 520.3 (MH^+)

PREPARATION 111

1-[(3*S*)-3-Amino-3-phenylpropyl]-4-[3-(4-fluorobenzyl)-1,2,4-oxadiazol-5-yl]-4-piperidinecarbonitrile



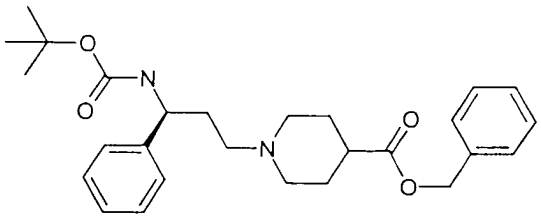
Obtained from the title compound of preparation 110 as an oil in 68% yield using a similar procedure to that in preparation 81.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.85 (1H, m), 2.00 (1H, m), 2.38 (8H, m), 2.85 (1H, m), 3.02 (1H, m), 4.04 (3H, m), 7.02 (2H, m), 7.27 (7H, m)

LRMS: m/z 420.2 (MH^+)

PREPARATION 112

Benzyl 1-[(3S)-3{(*tert*-butoxycarbonyl)amino}-3-phenylpropyl]-4-piperidine carboxylate



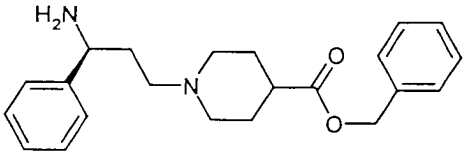
Obtained from the title compound of preparation 7 and benzyl 4-piperidinecarboxylate as an oil in 67% yield using a similar procedure to that in preparation 80.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.33 (9H, s), 1.60-2.12 (11H, m), 2.64-3.00 (2H, m), 4.75 (1H, s), 5.10 (2H, s), 6.55 (1H, s), 7.10-7.45 (10H, m)

LRMS: m/z 453.3 (MH^+)

PREPARATION 113

Benzyl 1-[(3S)-3-amino-3-phenylpropyl]-4-piperidine carboxylate



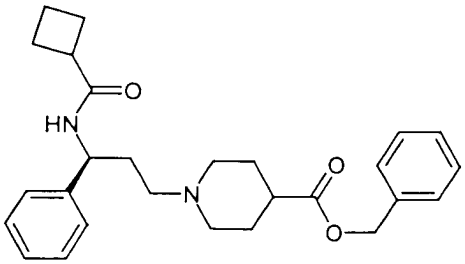
Obtained from the title compound of preparation 112 as an oil in 88% yield using a similar procedure to that in preparation 81.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.60-2.05 (10H, m), 2.25-2.44 (3H, m), 2.86 (2H, m), 3.97 (1H, m), 5.14 (2H, s), 7.23-7.43 (10H, m)

LRMS: m/z 353.3 (MH^+)

PREPARATION 114

Benzyl 1-{(3S)-3-[(cyclobutylcarbonyl)amino]-3-phenylpropyl}-4-piperidine carboxylate



A solution of the title compound of preparation 113 (10.3g, 29.2mmol) in dichloromethane (200ml) was treated with diisopropylethylamine (5.72ml, 32.1mmol) and cyclobutanecarbonylchloride (3.66ml, 32.1mmol). The mixture was stirred at room

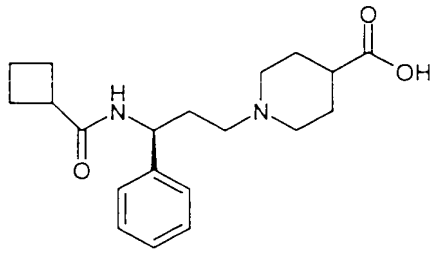
temperature under nitrogen for 18 hours then diluted with sodium carbonate solution and extracted with dichloromethane (2x). The combined organic extracts were washed with brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane:methanol (99:1) as eluant to afford the title compound, 4.63g.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.77-2.45 (16H, m), 2.80 (1H, m), 2.98-3.18 (2H, m), 5.11-5.26 (3H, m), 5.14 (2H, s), 7.18-7.45 (10H, m)

LRMS: m/z 435.3 (MH^+)

PREPARATION 115

1-{(3S)-3-[(Cyclobutylcarbonyl)amino]-3-phenylpropyl}-4-piperidinecarboxylic acid



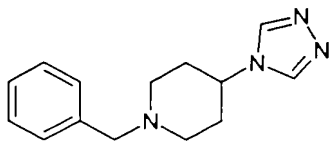
A solution the title compound of preparation 114 (7.63g, 17.6mmol) in ethanol (300ml) was hydrogenated at 1 atmosphere for 12 hours at room temperature using 10%palladium on carbon as a catalyst (700mg). The catalyst was removed by filtration through a glass-fibre filter, then the solvent was evaporated under reduced pressure to give the title compound as a white crystalline solid, 6.04g.

^{1}H NMR (400MHz, CD_3OD): δ [ppm] 1.16 (1H, m), 1.75-2.40 (13H, m), 2.75-3.05 (4H, m), 3.12 (1H, m), 3.23-3.45 (3H, m), 4.94 (1H, m), 7.23-7.46 (5H, m)

LRMS: m/z 345.0 (MH^+)

PREPARATION 116

1-Benzyl-4-(4*H*-1,2,4-triazol-4-yl)piperidine



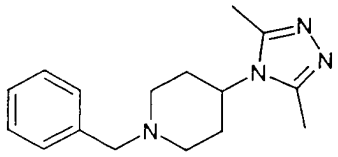
1-Benzyl-4-piperidinamine (617mg, 3.25mmol) was added to a solution of *N*'-[(*E*)-(dimethylamino)methylidene]-*N*,*N*-dimethylhydrazonoformamide (550mg, 3.90mmol) [J.Am.Chem.Soc, (1995), 117(22), 5951] and p-toluenesulphonic acid (62mg, 0.33mmol) in toluene (30ml). The reaction mixture was stirred for 24 hours at room temperature and the

solvent evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford the title compound as a white solid, 560mg.

^{1}H-NMR (300MHz, $CDCl_3$) : δ [ppm] 1.92-2.21 (6H, m), 3.03 (2H, d), 3.55 (2H, s), 4.04 (1H, m), 7.13-7.36 (5H, m), 8.21 (2H, s)

PREPARATION 117

1-Benzyl-4-(3,5-dimethyl-4*H*-1,2,4-triazol-4-yl)piperidine



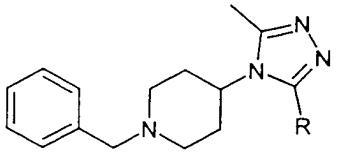
Lawessons reagent (11.69g, 28.9mmol) was added to a solution of *N*-(1-benzyl-4-piperidinyl)acetamide (6.1g, 26.3mmol) [J.Med.Chem, (1996), 39(19), 3769] in tetrahydrofuran (100ml). The reaction mixture was stirred at room temperature for 18 hours, and then evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (93:7:0.3) as eluant, to give a yellow oil, 2.8g.

Acetylhydrazide (919mg, 12.4mmol) was added to a solution of the intermediate thioamide and mercuric oxide (2.44g, 11.3mmol) in butanol (50ml). The reaction mixture was heated under reflux for 24 hours and then cooled and filtered through Arbocel® . The filtrate was evaporated under reduced pressure and the crude product was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant, to afford the title compound, 1.80g.

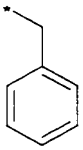
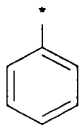
LRMS : m/z 271 (MH^+)

PREPARATIONS 118 to 119

The compounds of the following tabulated preparations:

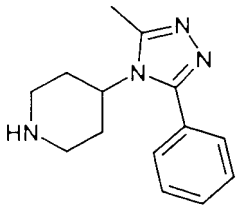


were prepared from the corresponding hydrazides, using similar methods to that described in preparation 117.

PREPARATION	R	YIELD	DATA
118		38%	^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.78 (2H, t), 1.95 (1H, dd), 2.00 (1H, dd), 2.08 (2H, m), 2.50 (3H, s), 2.81 (2H, d), 3.41 (2H, s), 3.78 (1H, m), 4.18 (2H, s), 7.15-7.39 (10H, m) LRMS: m/z 348 (MH^+)
119		29%	^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.78 (2H, d), 1.95 (2H, t), 2.20 (2H, m), 2.63 (3H, s), 2.93 (2H, d), 3.48 (2H, s), 4.18 (1H, m), 7.20 (5H, m), 7.40 (4H, m), 7.75 (1H, d) LRMS: m/z 333 (MH^+)

PREPARATION 120

4-(3-Methyl-5-phenyl-4*H*-1,2,4-triazol-4-yl)piperidine



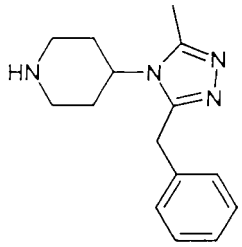
The title compound of preparation 119 (1.00g, 3.00mmol) was dissolved in ethanol (30ml) and 20% w/w palladium hydroxide on carbon (500mg) and ammonium formate (0.95g, 15.0mmol) added. The reaction was heated under reflux for 1 hour, cooled and filtered through a plug of Arbocel®. The filtrate was concentrated under reduced pressure and the crude product was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (80:20:1) as eluant to afford the title compound as a pale yellow oil, 400mg.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.78 (2H, d), 2.10 (1H, dd), 2.18 (1H, dd), 2.60 (2H, m), 2.63 (3H, s), 3.20 (2H, d), 4.10 (1H, m), 7.50 (5H, m)

LRMS: m/z 243 (MH^+)

PREPARATION 121

4-(3-Benzyl-5-methyl-4*H*-1,2,4-triazol-4-yl)piperidine



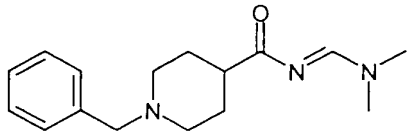
Obtained from the title compound of preparation 118 as an oil in 66% yield using a similar procedure to that in preparation 120.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.20-1.23 (1H, m), 1.35-1.41 (1H, m), 1.80-2.00 (4H, m), 2.38-2.48 (1H, m), 2.51 (2H, s), 3.02-3.10 (1H, m), 3.46 (3H, m), 3.60-3.72 (1H, m), 4.20 (1H, s), 7.15-7.35 (5H, m)

LRMS: m/z 257.2 (MH^+)

PREPARATION 122

1-Benzyl-*N*-[(*E*)-(dimethylamino)methylidene]-4-piperidinecarboxamide



A mixture of N-benzyl-4-piperidinecarboxamide (2.49g, 11.4mmol) [J.A.C.S. (1977), 99(6), 1858] and dimethylformamide dimethylacetal (10ml) was heated to 170°C, allowing continuous removal of solvent, and the mixture stirred for 10 minutes. The reaction was then cooled to 120°C and stirred for 90 minutes, followed by a further 18 hours at room temperature. The resulting crystals were filtered off and washed with pentane to afford the title compound as a white crystalline solid, 1.75g.

^{1}H-NMR (300MHz, $CDCl_3$) : δ [ppm] 1.55 (2H, m), 1.75 (2H, d), 1.93 (2H, t), 2.16 (1H, m), 2.74 (2H, d), 2.94 (3H, s), 3.08 (3H, s), 3.40 (2H, s), 7.20-7.32 (5H, m), 8.33 (1H, s)

LRMS : m/z 274 (MH^+)

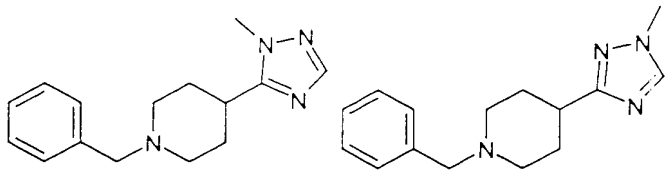
PREPARATION 123

1-Benzyl-4-(1-methyl-1*H*-1,2,4-triazol-5-yl)piperidine

and

PREPARATION 124

1-Benzyl-4-(1-methyl-1*H*-1,2,4-triazol-3-yl)piperidine



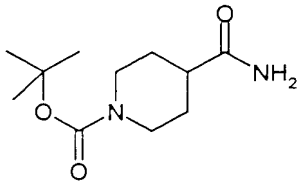
The title compound from preparation 122 (1.89g, 6.91mmol) was added to a solution of methyl hydrazine (0.4ml, 7.60mmol) in acetic acid (20ml). The reaction mixture was heated to 92°C for 4 hours and the solvent was evaporated under reduced pressure. The residue was basified using sodium hydrogen carbonate and the product extracted with ethyl acetate (x4). The combined organic extracts were washed with brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure to afford the title compounds as an oil, 2.74g.

^{1}H-NMR (300MHz, $CDCl_3$) : δ [ppm] 1.81-2.26 (6H, m), 2.88-3.06 (3H, m), 3.50-3.65 (2H, d), 3.85 (2H, d), 7.21-7.40 (5H, m), 7.79-7.92 (2H, 2xs)

LRMS : m/z 274 (MH^+)

PREPARATION 125

tert-Butyl 4-(aminocarbonyl)-1-piperidinecarboxylate



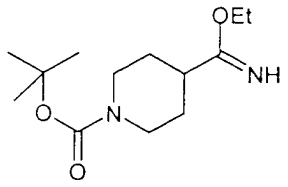
Ethyl chloroformate (4.6ml, 48.3mmol) was added slowly to a solution of 1-(*tert*-butoxycarbonyl)-4-piperidinecarboxylic acid (10g, 43.6mmol) in dichloromethane (100ml) stirred at 0°C. Triethylamine (7.6ml, 52.3mmol) was added with stirring over two minutes. 0.88 Ammonia solution (40ml) was added and the mixture allowed to warm to room temperature with stirring. The mixture was washed with water, 1M citric acid solution and brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure gave the title compound as white solid, 8.94g.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.43 (9H, m), 1.64 (2H, m), 1.83 (2H, m), 2.30 (1H, m), 2.78 (2H, t), 4.16 (2H, d), 5.4 (2H, bs)

LRMS: m/z 251 (MNa^+)

PREPARATION 126

tert-Butyl 4-[ethoxy(imino)methyl]-1-piperidinecarboxylate



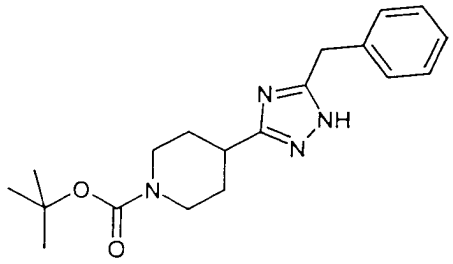
A solution of the title compound of preparation 125 (2.80g, 12.2mmol) in dichloromethane (30ml) was added slowly to triethyloxonium hexafluorophosphate (3.30g, 13.3mmol) in dichloromethane (20ml) at room temperature and the resultant mixture stirred at room temperature overnight. The mixture was basified with sodium hydrogen carbonate solution and then extracted with dichloromethane (x2). The combined organic solutions were dried ($MgSO_4$), filtered and evaporated under reduced pressure to afford the title compound as a thick yellow oil, 2.90g.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.26 (3H, m), 1.43 (9H,s), 1.64 (2H, d), 2.31 (1H, m), 2.75 (4H, m), 4.10 (4H, m)

LRMS: m/z 257 (MH^+)

PREPARATION 127

tert-Butyl-4-(5-benzyl-1*H*-1,2,4-triazol-3-yl)-1-piperidinecarboxylate



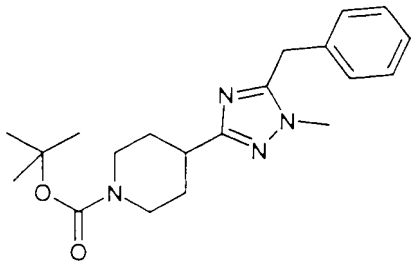
Phenylacetyl chloride (2.26ml, 17.0mmol) was added to a solution of the title compound of preparation 126 (4.00g, 15.6mmol) and triethylamine (2.5ml, 1.60mmol) in toluene (26ml) and stirred at room temperature for 90 minutes. Hydrazine hydrate (0.91ml, 19.0mmol) was added and the reaction mixture stirred at room temperature for 15 hours. The mixture was acidified by addition of 1M citric acid solution and extracted with ethyl acetate (x3). The combined organic solutions were washed with brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane:methanol (99:1) as eluant to afford the title compound, 1.70g.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.34 (9H, s), 1.75 (2H, m), 2.00 (2H, d), 2.90 (3H, m), 4.12 (4H, m), 7.30 (5H, m)

LRMS: m/z 343 (MH^+)

PREPARATION 128

tert-Butyl 4-(5-benzyl-1-methyl-1*H*-1,2,4-triazol-3-yl)-1-piperidinecarboxylate



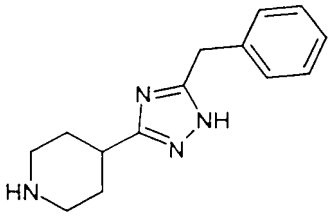
A solution of the title compound of preparation 126 (2.90g, 11.3mmol) and triethylamine (1.7ml, 12.3mmol) in toluene (20ml) was treated with phenylacetyl chloride (1.6ml, 12.1mmol) and stirred at room temperature for 1 hour. Methyl hydrazine (0.66ml, 12.5mmol) was added dropwise and the mixture stirred at room temperature for 5 hours. The mixture was acidified by addition of 1M citric acid solution and extracted with ethyl acetate (x3). The combined organic solutions were washed with brine, dried ($MgSO_4$), filtered and concentrated under reduced pressure to give a yellow oil. Purification of this residue by column chromatography on silica gel using dichloromethane: methanol (99:1) as eluant afforded the title compound, 1.10g.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.41 (9H, s), 1.72-1.85 (2H, m), 2.00 (2H, m), 2.83 (3H, m), 3.62 (3H, s), 4.10 (2H, s), 4.15 (2H, m), 7.15 (2H, d), 7.24-7.35 (3H, m)

LRMS: m/z 357 (MH^+)

PREPARATION 129

4-(5-Benzyl-1*H*-1,2,4-triazol-3-yl)piperidine trifluoroacetate



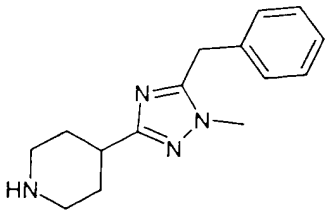
A solution of the title compound of preparation 127 (530mg, 1.50mmol) in dichloromethane (5ml) at 0°C was treated with trifluoroacetic acid (1ml) and stirred at room temperature for 3 hours. The mixture was concentrated under reduced pressure, toluene (20ml) added and removed under reduced pressure to afford the title compound as a yellow oil, 1.09g.

^{1}H NMR (400 MHz, CD_3OD): δ [ppm] 2.03 (2H, m), 2.25 (2H, m), 3.20 (3H, m), 3.50 (2H, m), 4.20 (2H, m), 7.30 (5H, m)

LRMS: m/z 243 (MH^+)

PREPARATION 130

4-(5-Benzyl-1-methyl-1*H*-1,2,4-triazol-3-yl)-1-piperidine



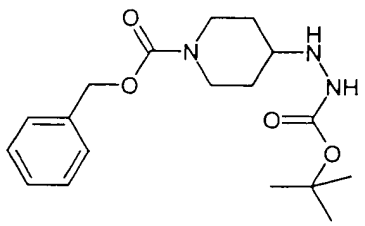
Obtained from the title compound of preparation 128 as an oil in 46% yield using a similar procedure to that in preparation 81.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.72-1.85 (2H, m), 2.05 (2H, m), 2.76 (2H, t), 2.83 (1H, m), 3.17 (2H, m), 3.60 (3H, s), 4.05 (2H, s), 7.15 (2H, d), 7.21-7.35 (3H, m)

LRMS: m/z 258 (MH^+)

PREPARATION 131

Benzyl 4-[2-(*tert*-butoxycarbonyl)hydrazino]-1-piperidinecarboxylate



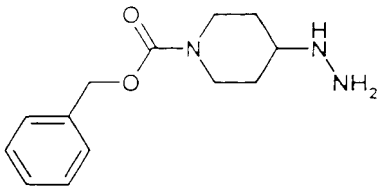
Benzyl 4-oxo-1-piperidinecarboxylate (10.0g, 42.9mmol), *tert*-butyl-1-hydrazinecarboxylate (5.70g, 42.9mmol) and sodium triacetoxyborohydride (13.6g, 64.1mmol) were stirred together for 4 hours at room temperature in dichloromethane/acetic acid (40ml, 10% solution). The solvents were evaporated under reduced pressure. The residue was basified with saturated sodium carbonate solution and extracted with ethyl acetate. The combined organic solutions were dried ($MgSO_4$), filtered and evaporated under reduced pressure to yield the title compound as a colourless gum, 14.2g.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.23-1.39 (2H, m), 1.45 (9H, s), 1.71-1.87 (2H, m), 2.89-3.08 (3H, m), 3.61-3.69 (1H, m), 3.87-3.97 (1H, m), 3.97-4.10 (2H, m), 5.68-5.81 (1H, bs), 5.94-6.06 (1H, bs), 7.26-7.39 (5H, m)

LRMS: m/z 350.0 (MH^+)

PREPARATION 132

Benzyl 4-hydrazino-1-piperidinecarboxylate



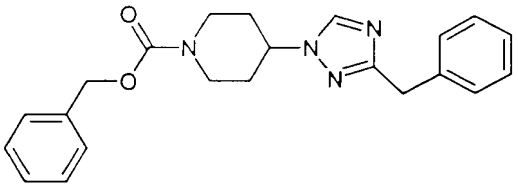
The title compound of preparation 131 (1.00g, 37.8mmol) in dichloromethane (250ml) was stirred at 0°C while trifluoroacetic acid (30ml, 390mmol) was added. The mixture was stirred for 16 hours and allowed to warm to room temperature. The solvents were removed under reduced pressure. The residue was basified with saturated sodium carbonate solution and extracted with dichloromethane (x4). The combined organic solutions were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using an eluant of dichloromethane:methanol:0.88 ammonia (95:5:0.5) to afford the title compound as a colourless gum, 4.25g.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.23-1.35 (2H, m), 1.81-1.94 (2H, m), 2.61-2.71(1H, m), 2.86-3.00 (2H, m), 4.00-4.24 (2H, m), 5.11 (2H, s), 7.26-7.37 (5H, m)

LRMS: m/z 250.1(MH^+)

PREPARATION 133

Benzyl 4-(3-benzyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinecarboxylate



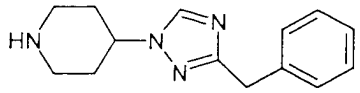
Phenylacetimidate (2.0g, 10.8mmol) and the title compound of preparation 132 (3.1g, 10.8mmol) were stirred in dichloromethane (100ml) at room temperature for 1 hour. The solvent was removed under reduced pressure and the residue was heated under reflux for 2 hours in triethyl orthoformate (50ml). The solvent was removed under reduced pressure. The residue was dissolved in ethyl acetate and washed with water (x2). The organic layer was dried ($MgSO_4$), filtered and evaporated under reduced pressure to give an oil which quickly crystallised on standing. The residue was purified by recrystallization from ethyl acetate to afford the title compound as a white solid, 1.73g.

^{1}H NMR (400 MHz, CD_3OD): δ [ppm] 1.87-2.00 (2H, m), 2.03-2.16 (2H, m), 2.94-3.15 (2H, m), 4.00 (2H, s), 4.20-4.29 (2H, m), 4.40-4.50 (1H, m), 5.13 (2H, s), 7.13-7.19 (1H, m), 7.19-7.40 (9H, m)

LRMS: m/z 377.2 (MH^+)

PREPARATION 134

4-(3-Benzyl-1*H*-1,2,4-triazol-1-yl)piperidine

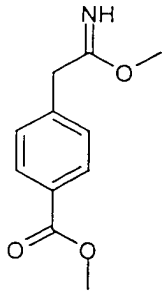


Obtained from the title compound of preparation 133 as an oil in 88% yield using a similar procedure to that in preparation 120.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.68-1.94 (2H, m), 2.10-2.20 (2H, m), 2.71-2.81 (2H, m), 3.20-3.29 (2H, m), 4.06 (2H, s), 4.16-4.26 (1H, m), 7.16-7.23 (1H, m), 7.23-7.35 (4H, m), 7.97 (1H, s)

PREPARATION 135

Methyl 4-(2-imino-2-methoxyethyl)benzoate



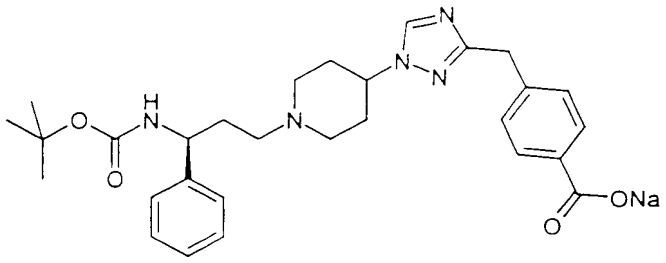
To a solution of methyl 4-(bromomethyl)benzoate (5.00g, 21.8mmol) and acetone cyanohydrin (3ml, 32.7mmol) stirring at room temperature in acetonitrile (200ml) was added 1,1,3,3-tetramethylguanidine (5.8ml, 45.8mmol) and the mixture stirred for 16 hours. The solvent was removed under reduced pressure. The residue was triturated with diethyl ether (x3), filtered and the filtrate evaporated under reduced pressure. The residue was purified by filtering through a pad of silica, eluting with diethyl ether to afford a colorless oil, 4.0g. The oil was dissolved in 200ml of diethyl ether and gaseous hydrogen chloride was bubbled though the solution until saturated while stirring at 0°C. Methanol (1.5ml, 37.2mmol) was added and the mixture stirred for 1 hour. The solvents were removed under reduced pressure and the residue was basified using saturated sodium carbonate solution and extracted with dichloromethane (x3). The combined organic solutions were dried ($MgSO_4$), filtered and evaporated under reduced pressure to afford the title compound as a colourless oil, 4.20g.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 3.60 (2H, s), 3.74 (3H, s), 3.92 (3H, s), 7.26-7.32 (2H, d), 8.00-8.06 (2H, d)

LRMS: m/z 208.1 (MH^+)

PREPARATION 136

Sodium 4-{[1-(1-{(3*S*)-3-[(*tert*-butoxycarbonyl)amino]-3-phenylpropyl}-4-piperidinyl)-1*H*-1,2,4-triazol-3-yl]methyl}benzoate



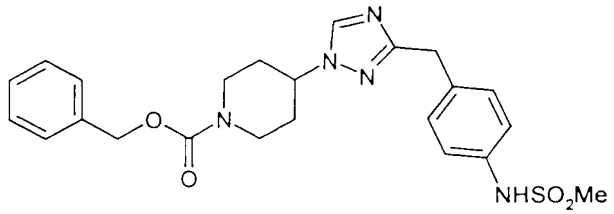
The title compound of preparation 132 (3.50g, 14.04mmol) and the title compound of preparation 135 (2.90g, 14.04mmol) were stirred together for 1 hour at room temperature methanol (50ml). The solvent was removed under reduced pressure. The residue was dissolved in triethylorthoformate (50ml) and heated under reflux for 3 hours. The solvent was removed under reduced pressure and the residue purified by column chromatography on silica gel using an eluant of dichloromethane:methanol:0.88 ammonia (95:5:0.5). The residue (4.00g, 9.18mmol), ammonium formate (4.00g, 82.49mmol) and 20% w/w palladium hydroxide on carbon (400mg) were heated under reflux for 30 minutes in ethanol (100ml). The mixture was filtered through Arbocel® and the filtrate evaporated under reduced pressure.

The residue (2.50g, 8.32mmol), the title compound of preparation 7 (2.00g, 8.32mmol) and sodium triacetoxyborohydride (2.50g, 12.48mmol) were stirred at room temperature for 1 hour in dichloromethane:acetic acid (30ml, 10%). The solvents were evaporated under reduced pressure and the residue was basified with saturated sodium carbonate solution and extracted with dichloromethane (x3). The combined organic solutions were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (98:2:0.25) as eluant to give a foam, 2.50g. The residue (1.00g, 1.87mmol) and sodium hydroxide (150mg, 3.74mmol) was stirred for 2 hours at 50°C in a mixture of dioxane:water (5:1). The solvents were removed under reduced pressure to afford a white solid, 993mg.

LRMS: m/z 520.1 (MH^+)

PREPARATION 137

N-{4-[(1-{1-[1-(Benzyloxy)vinyl]-4-piperidinyl}-1*H*-1,2,4-triazol-3-yl)methyl]phenyl}methanesulphonamide



The title compound of preparation 131 (1.90g, 9.04mmol) was stirred at room temperature in diethyl ether:methanol (100ml, 4:1) while hydrogen chloride gas was bubbled through the solution until saturated. The mixture was stirred for 16 hours and the solvents were removed under reduced pressure. The residue was basified with saturated sodium carbonate solution and extracted with dichloromethane (x3). The combined organic solutions were dried ($MgSO_4$), filtered and evaporated under reduced pressure.

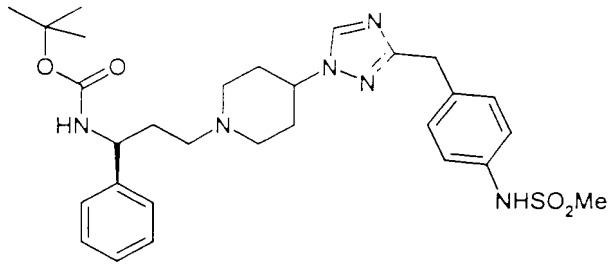
In a separate flask the title compound of preparation 47 (1.00g, 4.76mmol) was dissolved in 20ml of diethyl ether and gaseous hydrogen chloride was bubbled though the solution until saturated while stirring at 0°C. Methanol (1.5ml, 37.2mmol) was added and the mixture stirred for 1 hour. The solvents were removed under reduced pressure and the residue was basified using saturated sodium carbonate solution and extracted with dichloromethane (x3). The combined organic solutions were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The crude hydrazine (595mg, 2.46mmol) and the intermediate amidoxime (600mg, 2.41mmol) were stirred together at room temperature for 3 hours in 40ml of methanol. The solvent was removed under reduced pressure. The residue was dissolved in triethyl orthoacetate (30ml) and heated under reflux for 30 minutes. The solvent was removed under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford the title compound as a foam, 560mg.

^{1}H NMR (400 MHz, CD_3OD): δ [ppm] 1.68-2.00 (2H, m), 2.05-2.15 (2H, m), 2.90 (3H, s), 2.97-3.11 (2H, m), 3.99 (2H, s), 4.21-4.31 (2H, m), 4.40-4.50 (1H, m), 5.15 (2H, s), 7.11-7.16 (2H, d), 7.16-7.26 (2H, d), 7.30-7.39 (4H, m), 8.35 (1H, s)

LRMS: m/z 492.1 (MNH_4^+)

PREPARATION 138

tert-Butyl-(1*S*)-3-[4-(3-{4-[(methylsulphonyl)amino]benzyl}-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropylcarbamate

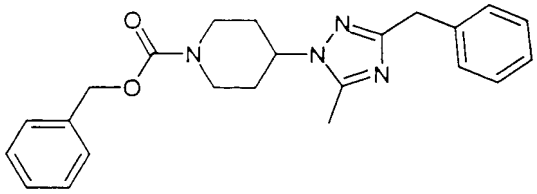


The title compound of preparation 137 (500mg, 1.06mmol), ammonium formate (500mg, 7.93mmol) and 20% w/w palladium hydroxide on carbon (50mg) were heated under reflux in ethanol (20ml) until gas evolution ceased. The mixture was filtered through Arbocel® and the filtrate evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using gradient elution of dichloromethane:methanol:0.88 ammonia (90:10:1 to 80:20:4). The residue (300mg, 0.89mmol) and the title compound of preparation 7 (222mg, 0.88mmol) and sodium triacetoxyborohydride (285mg, 1.34mmol) were stirred together at room temperature for 30 minutes in a mixture of dichloromethane:acetic acid (30ml, 10%). The solvents were removed under reduced pressure and the residue was basified with saturated sodium carbonate solution and extracted with ethyl acetate (3x). The combined organic solutions were dried ($MgSO_4$), filtered and evaporated under reduced pressure to afford the title compound as a white solid, 407mg.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.31-1.48 (9H, m), 1.48-1.60 (2H, m), 1.77-1.90 (1H, m), 1.90-2.23 (4H, m), 2.26-2.44 (2H, m), 2.95 (3H, s), 3.02-3.10 (1H, m), 3.66-3.74 (1H, m), 4.03 (2H, s), 4.06-4.16 (1H, m), 4.74-5.02 (2H, m), 6.16-6.26 (1H, m), 6.35-6.44 (1H, m), 7.10-7.15 (2H, d), 7.19-7.37 (7H, m), 7.00 (1H, s)

PREPARATION 139

Benzyl 4-(3-benzyl-5-methyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinecarboxylate



Hydrogen chloride gas was bubbled through a solution of the title compound of preparation 131 (3.00g, 8.59mmol) in methanol (50ml), at 0°C, for 1 hour. The solvent was removed under reduced pressure and the residue dissolved in dichloromethane (50ml) and triethylamine (2.51ml, 18.00mmol) and phenylacetimidate hydrochloride (1.59g, 8.59mmol) added. The reaction was stirred at room temperature for 1 hour and the solvent removed under reduced pressure, the residue was dissolved in triethyl orthoacetate (20ml) and heated under reflux for 12 hours. The reaction was cooled, the solvent removed under reduced

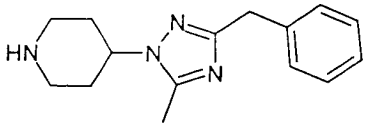
pressure and the resulting brown oil was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford the title compound as a pale yellow oil, 2.20g.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.83 (2H, d), 2.08 (1H, dd), 2.20 (1H, dd), 2.40 (3H, s), 2.85 (2H, m), 3.95 (2H, s), 4.10 (1H, m), 4.38 (2H, m), 5.18 (2H, m), 7.05-7.39 (10H, m)

LRMS: m/z 391 (MH^+)

PREPARATION 140

4-(3-Benzyl-5-methyl-1*H*-1,2,4-triazol-1-yl)piperidine



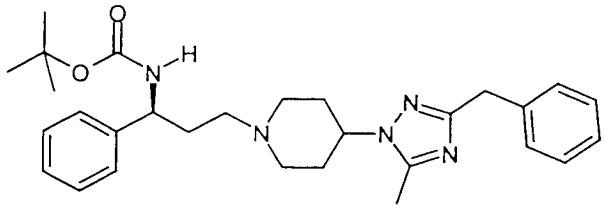
Obtained from the title compound of preparation 139 as an oil in 100% yield using a similar procedure to that in preparation 120.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 2.03-2.38 (4H, m), 2.41 (3H, s), 3.01 (2H, m), 3.43 (2H, m), 4.01 (2H, s), 4.23 (1H, m), 7.18 (5H, m), 8.43 (1H, s)

LRMS: m/z 257 (MH^+)

PREPARATION 141

tert-Butyl (1*S*)-3-[4-(3-benzyl-5-methyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropylcarbamate



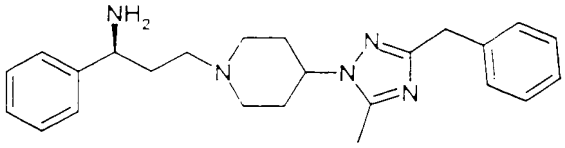
Obtained from the title compounds of preparations 7 and 140 as an oil in 59% yield using a similar procedure to that in preparation 80.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.41 (9H, s), 1.85 (4H, m), 2.05 (4H, m), 2.38 (4H, m), 2.41 (3H, s), 2.98 (1H, d), 3.14 (1H, d), 4.00 (2H, s), 4.81 (1H, s), 7.28 (10H, m)

LRMS: m/z 491 (MH^+)

PREPARATION 142

(1*S*)-3-[4-(3-Benzyl-5-methyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenyl-1-propanamine



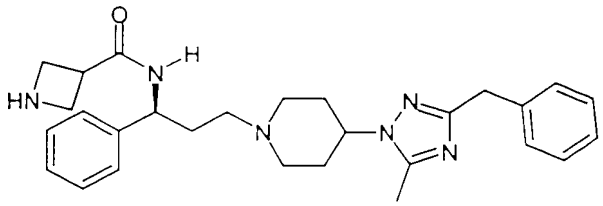
The title compound of preparation 141 (1.70g, 3.50mmol) was dissolved in methanolic hydrochloric acid (30ml, 2.5M) and stirred at room temperature for 2 hours. The solvent was removed under reduced pressure and saturated sodium carbonate added. The aqueous was extracted with dichloromethane (3x), the combined organic solutions were dried ($MgSO_4$), filtered and the solvent removed under reduced pressure to afford the title compound as a clear oil, 1.40g.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.68-1.91 (6H, m), 1.98-2.18 (3H, m), 2.21 (2H, m), 2.38 (4H, m), 3.13 (2H, m), 3.89-4.03 (4H, m), 7.18-7.41 (10H, m)

LRMS: m/z 390 (MH^+)

PREPARATION 143

N-{(1*S*)-3-[4-(3-Benzyl-5-methyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}-3-azetidinecarboxamide



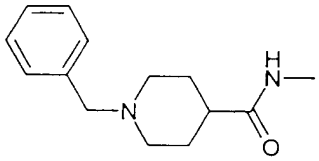
1-(3-Dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (177mg, 0.93mmol) was added to a stirred solution of the title compound of preparation 13 (186mg, 0.93mmol) and the title compound of preparation 142 (300mg, 0.76mmol) in dichloromethane (20ml). After 1 hour trifluoroacetic acid (5ml) was added and the reaction stirred for 12 hours. The solvent was removed under reduced pressure and the resulting oil was loaded directly onto a column of silica and eluted with dichloromethane:methanol:0.88 ammonia (95:5:0.5) to afford the title compound as a white foam, 200mg.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.78-2.40 (15H, m), 2.96 (1H, d), 3.12 (1H, d), 3.39 (2H, m), 3.66-4.02 (6H, m), 5.06 (1H, dd), 7.08-7.19 (9H, m), 8.03 (1H, d)

LRMS: m/z 473 (MH^+)

PREPARATION 144

1-Benzyl *N*-methyl-4-piperidinecarboxamide



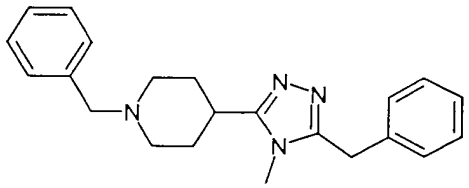
N-Benzyl 4-piperidinecarboxylic acid (5.00g, 22.8mmol), 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (5.25g, 27.4mmol) and 1-hydroxybenzotriazole hydrate (3.84g, 25.1mmol) were added to a solution of methylamine (11.4ml of a 2.0M solution in tetrahydrofuran, 22.8mmol) in dichloromethane (100ml). The mixture was stirred for 1 hour at room temperature, then partitioned between dichloromethane and water. The organic layer was separated and washed with brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure to furnish a pale yellow solid, 3.50g.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.78 (3H, m), 2.05 (3H, m), 2.79 (3H, d), 2.98 (3H, m), 3.50 (2H, s), 7.21 (m, 5H)

LRMS: m/z 233 (MH^+)

PREPARATION 145

1-Benzyl-4-(5-benzyl-4-methyl-4*H*-1,2,4-triazol-3-yl)piperidine



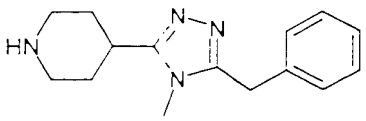
Lawesson's reagent (6.76g, 16.7mmol) was added in one portion to a solution of the title compound of preparation 144 (3.50g, 15.2mmol) in toluene (100ml) and the mixture stirred at room temperature overnight. The reaction mixture was filtered through a short plug of silica gel washing with dichloromethane (100ml) and the solvent removed under reduced pressure to furnish a yellow foam, 5.00g. The foam was dissolved in n-butanol (100ml) and mercury(II)oxide (4.81g, 22.2mmol) and phenylacetic hydrazide (3.02g, 20.2mmol) added. The reaction was heated under reflux for 12 hours, cooled, filtered through a plug of Arbocel® and the solvent removed under reduced pressure. The crude product was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford the title compound as a pale yellow oil, 0.85g.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.60-2.20 (6H, m), 2.80-3.00 (3H, m), 3.28 (3H, s), 3.58 (2H, m), 4.19 (2H, m), 7.19-7.40 (10H, m)

LRMS: m/z 347 (MH^+)

PREPARATION 146

4-(5-Benzyl-4-methyl-4*H*-1,2,4-triazol-3-yl)piperidine



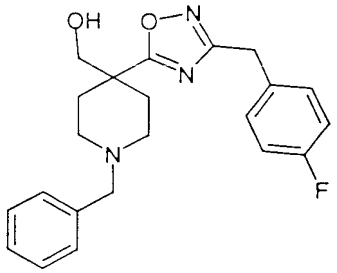
Obtained from the title compound of preparation 145 as an oil in 41% yield using a similar procedure to that in preparation 120.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.95 (4H, m), 2.20-2.60 (4H, br m), 2.80 (3H, m), 3.31 (2H, m), 4.20 (2H, s), 7.10-7.40 (5H, m)

LRMS: m/z 257 (MH^+)

PREPARATION 147

{1-Benzyl-4-[3-(4-fluorobenzyl)-1,2,4-oxadiazol-5-yl]-4-piperidinyl}methanol



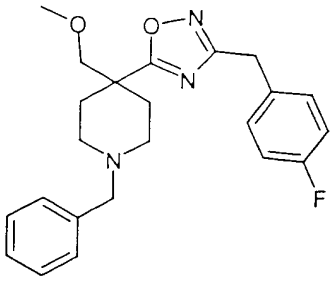
Sodium borohydride (160mg, 4.20mmol) was added to a stirred solution of the title compound of preparation 102 (1.35g, 3.53mmol) in methanol (15ml) and the reactants stirred at ambient temperature for 2 hours. The methanol was evaporated under reduced pressure and the residue partitioned between dichloromethane and water. The organic extract was separated, concentrated under reduced pressure and the residue purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (90:10:1) as eluant, to afford the title compound as an oil, 860mg.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.79 (2H, m), 2.23 (4H, m), 2.65 (2H, m), 3.46 (2H, s), 3.74 (2H, s), 4.05 (2H, s), 7.02 (2H, m), 7.26 (7H, m)

LRMS m/z 382.4 (MH^+)

PREPARATION 148

1-Benzyl-4-[3-(4-fluorobenzyl)-1,2,4-oxadiazol-5-yl]-4-(methoxymethyl)piperidine



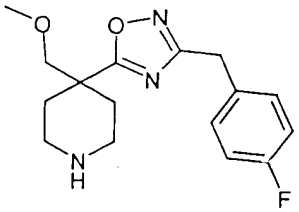
To a stirred solution of the title compound of preparation 147 (495mg, 1.31mmol) in dry acetonitrile (8ml) was added potassium *tert*-butoxide (184mg, 1.56mmol) and methyl tosylate (296mg, 1.56mmol) and the solution stirred at ambient temperature for 5 days. The solution was partitioned between ethyl acetate and water. The organic layer was separated, concentrated under reduced pressure and purified by column chromatography on silica gel using methanol:dichloromethane (95:5) as eluant, to afford the title compound as an oil 270mg.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.82 (2H, m), 2.05 (2H, m), 2.50 (2H, m), 2.70 (2H, m), 3.22 (3H, s), 3.42 (2H, s), 3.52 (2H, s), 4.04 (2H, s), 7.02 (2H, m), 7.26 (7H, m)

LRMS m/z 396.5 (MH^+)

PREPARATION 149

4-[3-(4-Fluorobenzyl)-1,2,4-oxadiazol-5-yl]-4-(methoxymethyl)piperidine



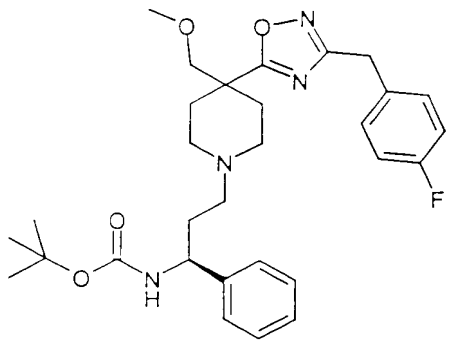
1-Chloroethyl chloroformate (0.96ml, 0.87mmol) was added to a solution of the title compound of preparation 148 (265mg, 0.67mmol) in dichloromethane (5ml). The reaction mixture was stirred for 24 hours at ambient temperature, then concentrated under reduced pressure. The residual oil was dissolved in methanol (5ml) and the reaction mixture heated under reflux for 2 hours. Silica gel was added to the cooled solution, which was concentrated under reduced pressure and purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant, to afford the title compound as a gum, 160mg.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 2.01 (2H, m), 2.39 (2H, m), 2.81 (2H, m), 3.24 (5H, m), 3.53 (2H, s), 4.05 (2H, s), 7.02 (2H, m), 7.26 (2H, m)

LRMS m/z 306 (MH^+)

PREPARATION 150

tert-Butyl (1*S*)-3-[4-[3-(4-fluorobenzyl)-1,2,4-oxadiazol-5-yl]-4-(methoxymethyl)-1-piperidinyl]-1-phenylpropylcarbamate



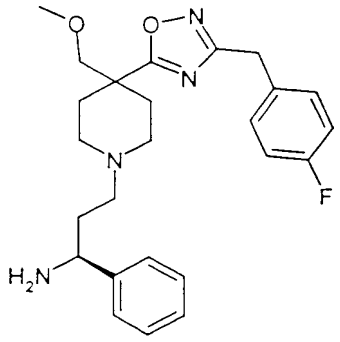
Obtained from the title compounds of preparations 7 and 149 as an oil in 93% yield using a similar procedure to that in preparation 80.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.28 (9H, s), 1.87 (6H, m), 2.28 (4H, m), 2.66 (1H, m), 2.78 (1H, m), 3.22 (3H, s), 3.49 (2H, s), 4.04 (2H, s), 4.77 (1H, m), 6.72 (1H, m), 6.98 (2H, t), 7.25 (7H, m)

LRMS: m/z 539.6 (MH^+)

PREPARATION 151

(1S)-3-[4-[3-(4-Fluorobenzyl)-1,2,4-oxadiazol-5-yl]-4-(methoxymethyl)-1-piperidinyl]-1-phenyl-1-propanamine

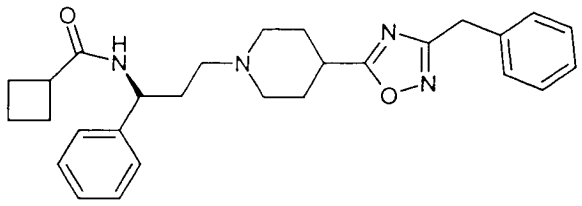


Obtained from the title compound of preparation 150 as an oil in 98% yield using a similar procedure to that in preparation 81.

LRMS: m/z 439.7 (MH^+)

EXAMPLE 1

N-{(1*S*)-3-[4-(3-Benzyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide



The title compounds of preparation 39 (200mg, 0.82mmol) and preparation 8 (285mg, 1.23mmol) were stirred together with sodium triacetoxyborohydride (209mg, 0.98mmol) in dichloromethane:acetic acid (10ml, 10%) for 4 hours at room temperature. Saturated aqueous sodium bicarbonate solution was added and the product extracted with dichloromethane (3x). The combined organic layers were washed with water and brine, dried ($MgSO_4$), filtered and the solvent evaporated under reduced pressure. The product was purified by chromatography on silica gel using ethyl acetate:methanol (95:5) as eluant, then dissolved in diethyl ether saturated with hydrogen chloride gas. Evaporation to dryness provided the title compound as the hydrochloride salt, 60mg.

Found C, 64.68; H, 7.26; N, 10.51%

$C_{28}H_{34}N_4O_2$;1HCl;1.4H_2O requires C, 64.64; H, 7.32; N, 10.77%

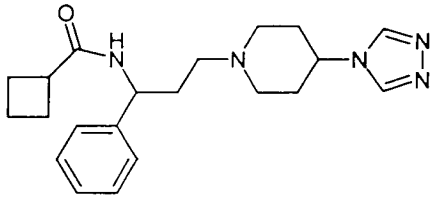
^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.78-2.20 (13H, m), 2.20-2.40 (3H, m), 2.81-2.95 (2H, m), 2.95-3.00 (2H, m), 4.05 (2H, s), 5.10 (1H, m), 7.17-7.25 (2H, m), 7.25-7.35 (7H, m), 7.45-7.55 (1H, m)

LRMS: m/z 459 (MH^+)

$[\alpha]_D$: -45.6 (c = 0.34, methanol)

EXAMPLE 2

N-{1-Phenyl-3-[4-(4*H*-1,2,4-triazol-4-yl)-1-piperidinyl]propyl}cyclobutanecarboxamide



The title compound of preparation 116 (560mg, 2.31mmol) was dissolved in ethanol (20ml) and 20% w/w palladium hydroxide on carbon (500mg) and ammonium formate (728mg, 11.5mmol) added. The reaction was heated under reflux for 1 hour, cooled and filtered through a plug of Arbocel®. The filtrate was concentrated under reduced pressure and the resulting oil and the title compound of preparation 3 were used to prepare the title

compound using a similar method to example 1. The reaction mixture was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford the title compound as a white foam, 50mg.

Found C, 66.90; H, 7.92; N, 18.68%

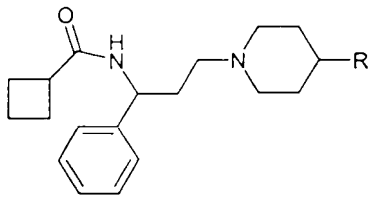
$C_{21}H_{29}N_5O;0.5H_2O$; requires C, 66.64; H, 7.95; N, 19.06%

^{1}H-NMR (300 MHz, $CDCl_3$): δ [ppm] 1.82-2.45 (17H, m), 2.95-3.12 (3H, m), 4.05 (1H, m), 5.13 (1H, m), 7.21-7.40 (5H, m), 8.21 (2H, m)

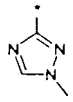
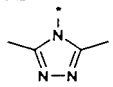
LRMS: m/z 368 (MH^+)

EXAMPLE 3-5

The compounds of the following tabulated examples with the general formula:



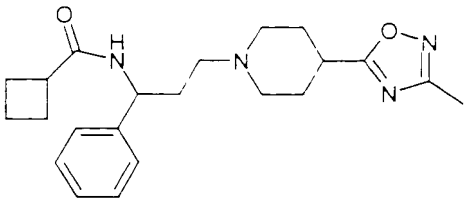
were prepared using a similar method to example 2 from the title compound of preparation 3 and the corresponding benzylamine.

EXAMPLE	R	YIELD	DATA
3[1]	 *N*-{3-[4-(1-Methyl-1*H*-1,2,4-triazol-5-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide	9%	Found C, 52.96; H, 7.16; N, 13.01% $C_{22}H_{31}N_5O;HCl;1.1CH_2Cl_2;0.8H_2O$ requires C, 52.77; H, 6.86; N, 13.32% ^{1}H-NMR (400 MHz, $CDCl_3$): δ [ppm] 1.75- 2.46 (16H, m), 2.75 (1H, m), 2.95-3.20 (3H, m), 3.85 (3H, s), 5.12 (1H, m), 7.19-7.40 (5H, m), 7.60 (1H, d), 7.81 (1H, s). LRMS: m/z 382 (MH^+)
4[1]	 *N*-{3-[4-(1-Methyl-1*H*-1,2,4-triazol-3-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide	10%	Found C, 53.42; H, 7.10; N, 13.57% $C_{22}H_{31}N_5O;HCl;CH_2Cl_2;0.8H_2O$ requires C, 53.40; H, 6.94; N, 13.54% ^{1}H-NMR (400 MHz, $CDCl_3$): δ [ppm] 1.76-2.43 (16H, m), 2.79 (1H, m), 2.88 (1H, d), 3.08 (2H, m), 3.83 (3H, s), 5.48 (1H, m), 7.15-7.35 (5H, m), 7.92 (1H, s), 8.06 (1H, d) LRMS: m/z 382 (MH^+)
5	 *N*-{3-[4-(3,5-Dimethyl-4*H*-1,2,4-triazol-4-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide	4%	^{1}H-NMR (300 MHz, $CDCl_3$): δ [ppm] 1.80-2.40 (16H, m), 2.50 (6H, s), 3.00 (1H, t), 3.12 (2H, d), 3.83 (1H, m), 5.12 (1H, m), 6.55 (1H, d), 7.23-7.39 (5H, m)

1 = Product obtained as the hydrochloride salt

EXAMPLE 6

N-{1-Phenyl-3-[4-(3-methyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]propyl}cyclobutanecarboxamide



A mixture of the title compound of preparation 21 (566mg, 2.27mmol) and sodium hydroxide (136mg, 3.41mmol) in ethanol (20ml) was stirred for 2 hours at room temperature and the solvent evaporated under reduced pressure. This intermediate and the title compound of preparation 3 were then used to prepare the title compound using a similar method to example 1. The reaction mixture was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (98:2:0.25). The product was dissolved in methanolic hydrochloric acid (3ml, 2.5M), and the solvent evaporated under reduced pressure to afford the title compound, 85mg.

Found C, 62.16; H, 7.53; N, 12.19%

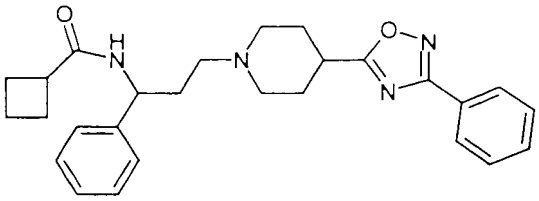
$C_{22}H_{30}N_4O_2$;HCl;0.6MeOH; requires C, 61.69; H, 7.70; N, 12.73%

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.80-2.45 (16H, m), 3.06-3.40 (6H, m), 3.62-3.80 (2H, m), 5.00 (1H, dd), 7.20-7.40 (5H, m)

LRMS: m/z 383 (MH^+)

EXAMPLE 7

N-{1-Phenyl-3-[4-(3-phenyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]propyl}cyclobutanecarboxamide



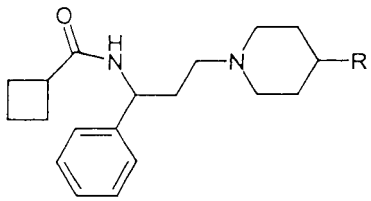
The title compounds of preparations 3 and 37 were used to prepare the title compound using a similar method to example 1. The reaction mixture was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (98:2:0.25) as eluant to afford the title compound, 218mg.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.60 (3H, s), 1.78-2.48 (14H, m), 2.93 (1H, d), 3.04 (2H, m), 5.13 (1H, m), 7.20-7.40 (5H, m), 7.50 (3H, m), 8.09 (2H, m)

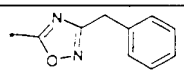
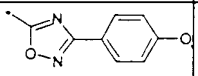
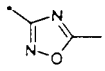
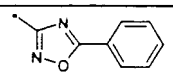
LRMS: m/z 445 (MH^+)

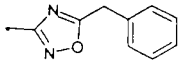
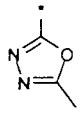
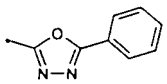
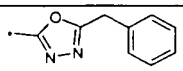
EXAMPLE 8-15

The compounds of the following tabulated examples with the general formula:



were prepared using a similar method to example 1 from the title compound of preparation 3 and the corresponding amine.

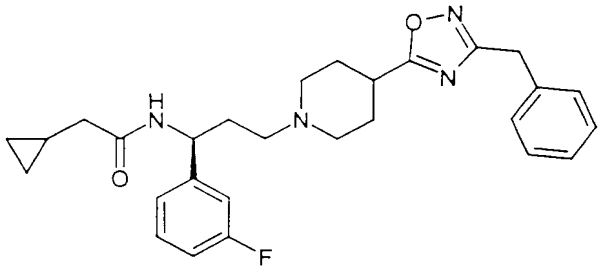
EXAMPLE	R	YIELD	DATA
8[1]	 *N*-{3-[4-(3-Benzyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide	51%	^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.74-2.42 (9H, m), 2.48-3.20 (8H, m), 3.17-3.55 (2H, m), 3.68 (1H, m), 4.06 (2H, d), 4.97 (1H, s), 7.20-7.40 (10H, m), 8.98 (1H, m) LRMS : 459 (MH^+)
9	 *N*-(3-{4-[3-(4-Methoxyphenyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)cyclobutanecarboxamide	32%	^{1}H NMR (300 MHz, CD_3OD): δ [ppm] 1.80-2.58 (14H, m), 3.04-3.84 (4H, m), 3.88 (3H, s), 4.96-5.06 (1H, m), 7.08 (2H, d), 7.22-7.46 (5H, m), 7.98 (2H, d) LRMS: m/z 476 (MH^+)
10	 *N*-{3-[4-(5-Methyl-1,2,4-oxadiazol-3-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide	5%	^{1}H NMR (300 MHz, CD_3OD): δ [ppm] 1.80-2.40 (15H, m), 2.58 (3H, s), 3.03-3.24 (5H, m), 3.89 (1H, m), 4.97 (1H, m), 7.25-7.40 (5H, m) LRMS: m/z 383.3 (MH^+) Melting point [°C]: >60 (softens to gum)
11[1]	 *N*-{1-Phenyl-3-[4-(5-phenyl-1,2,4-oxadiazol-3-yl)-1-piperidinyl]propyl}cyclobutanecarboxamide	30%	^{1}H NMR (300 MHz, CD_3OD): δ [ppm] 1.78-1.92 (1H, m), 1.92-2.05 (1H, m), 2.05-2.45 (11H, m), 3.10-3.55 (6H, m), 3.40-3.62 (1H, m), 3.62-3.80 (1H, m), 7.20-7.45 (5H, m), 7.52-7.69 (3H, m), 8.05-8.18 (2H, m) LRMS: m/z 445.2 (MH^+)

12[1]	 *N*-{3-[4-(5-Benzyl-1,2,4-oxadiazol-3-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide	35%	Found C, 62.23; H, 7.26; N, 10.15%. $C_{28}H_{34}N_4O_2$;1HCl;2.5H_2O requires C, 62.23; H, 7.46; N, 10.37%. ^{1}H NMR (300 MHz,CD_3OD): δ [ppm] 1.78-2.40 (12H, m), 3.04-3.38 (6H, m), 3.58-3.75 (2H, m), 4.20-4.35 (2H, m), 4.92-5.11 (1H, m), 7.21-7.45 (10H, m) LRMS: m/z 459.2 (MH^+)
13	 *N*-{3-[4-(5-Methyl-1,3,4-oxadiazol-2-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide	67%	^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.76-2.62 (16H, m), 2.53 (3H, s), 2.83-3.15 (4H, m), 5.18 (1H, m), 7.20-7.38 (5H, m), 7.52 (1H, d) LRMS: m/z 384 (MH^+)
14[1]	 *N*-{1-Phenyl-3-[4-(5-phenyl-1,3,4-oxadiazol-2-yl)-1-piperidinyl]propyl}cyclobutanecarboxamide	95%	^{1}H NMR (300 MHz, CD_3OD): δ [ppm] 1.82-2.34 (9H, m), 2.52 (2H, d), 3.07-3.83 (10H, m), 5.01 (1H, m), 7.27-7.42 (5H, m), 7.60 (3H, m), 8.06 (2H, m) LRMS: m/z 445 (MH^+)
15	 *N*-{3-[4-(5-Benzyl-1,3,4-oxadiazol-2-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide	8%	^{1}H NMR (300 MHz, CD_3OD): δ [ppm] 1.78-2.38 (14H, m), 2.92-3.22 (5H, m), 3.56-3.78 (3H, m), 4.19-4.25 (1H, m), 7.12 7.58 (10, m) LRMS: m/z 459.2 (MH^+)

1 = Product obtained as the hydrochloride salt

EXAMPLE 16

N-[(1*S*)-3-[4-(3-Benzyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-(3-fluorophenyl)propyl]-2-cyclopropylacetamide



Diisobutylaluminium hydride (42.1ml of a 1.0M solution in dichloromethane, 42.1mmol) was added dropwise to a solution of the title compound of preparation 12 (5.7g, 19.1mmol) in dichloromethane (100ml) at -78°C. The reaction mixture was stirred at this temperature for 1 hour, then methanol (5ml) pre-cooled to -78°C was added. The mixture was warmed to room temperature and washed with 2M hydrochloric acid, water and brine, dried ($MgSO_4$), filtered and the solvent evaporated under reduced pressure to afford the aldehyde as a yellow oil, 3.3g. From this oil (485mg, 1.81mmol), the title compound of preparation 39 (420mg, 1.81mmol) and sodium triacetoxyborohydride (578mg, 2.73mmol) were stirred together for 72 hours at room temperature in dichloromethane:acetic acid (30ml, 10%). The solvents were evaporated under reduced pressure. The residue was dissolved in ethyl acetate and washed with saturated aqueous sodium carbonate solution then water. The organic layer was dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue (700mg, 1.42mmol) was stirred for 1 hour at room temperature in dichloromethane (14ml) and trifluoroacetic acid (14ml). The solvents were evaporated under reduced pressure. The residue was basified with saturated aqueous sodium bicarbonate solution and extracted with dichloromethane (3x). The combined organic layers were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using dichlorormethane:methanol:0.88 ammonia (97:3:0.3) as eluant. A portion of the residue (100mg, 0.25mmol), 2-cyclopropylacetic acid (28mg, 0.28mmol), 1-hydroxybenzotriazole hydrate (41mg, 0.3mmol), 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (63mg, 0.33mmol) and triethylamine (46µl, 0.33mmol) were stirred for 2 hours at room temperature in dichloromethane (20ml). The solvent was evaporated under reduced pressure. The residue was dissolved in ethyl acetate and washed with water. The organic layer was dried ($MgSO_4$), filtered and evaporated. The residue was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (98:2:0.25) as eluant to afford the title compound as an oil, 97mg.

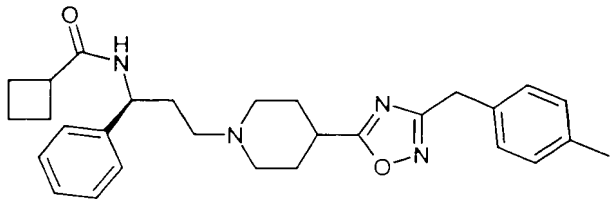
^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 0.16-0.23 (2H, m), 0.58-0.65 (2H, m), 0.97-1.08 (1H, m), 1.81-1.97 (3H, m), 1.97-2.23 (7H, m), 2.23-2.40 (2H, m), 2.82-2.95 (2H, m), 2.95-

3.05 (1H, m), 4.05 (2H, s), 5.08-5.16 (1H, m), 6.89-7.00 (2H, m), 7.00-7.06 (1H, d), 7.23-7.35 (6H, m), 7.63-7.71 (1H, m)

LRMS: m/z 477.3 (MH^+)

EXAMPLE 17

N-((1*S*)-3-{4-[3-(4-Methylbenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)cyclobutanecarboxamide



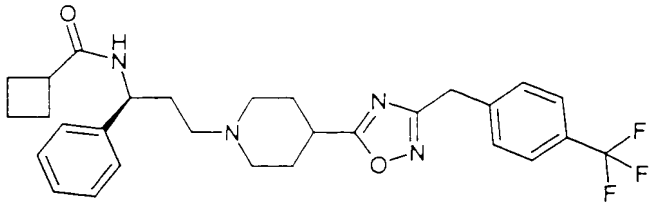
The title compound of preparation 77 (200mg, 0.56mmol) in dichloromethane (10ml) was treated with trifluoroacetic acid (4ml). The solution was stirred at room temperature for 12 hours. The solvent was evaporated under reduced pressure and the residue was partitioned between saturated aqueous sodium carbonate solution and dichloromethane. The aqueous layer was extracted with dichloromethane (2x). The combined organic layers were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue obtained (131mg, 0.51mmol), the title compound of preparation 8 (130mg, 0.56mmol) and sodium triacetoxyborohydride (162mg, 0.76mmol) were stirred in dichloromethane:acetic acid (20ml, 10%) at room temperature for 3 days. The reaction mixture was basified with saturated aqueous sodium carbonate solution. The aqueous layer was extracted with dichloromethane (2x) and the combined organic extracts washed with brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by preparative HPCL (phenomonex magellenC_{18} (2) aqueous TFA 0.1%:acetonitrile 1:19-19:1) to afford the title compound, 38mg.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.71-2.60 (16H, m), 2.61-2.82 (1H, m), 2.81-3.25 (4H, m), 3.32-3.83 (2H, m), 4.02 (2H, s), 4.95 (1H, s), 6.75 (1H, m), 7.15-7.47 (9H, m)

LRMS: m/z 473.3 (MH^+)

EXAMPLE 18

N-((1*S*)-3-{4-[3-(4-Trifluoromethylbenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)cyclobutanecarboxamide



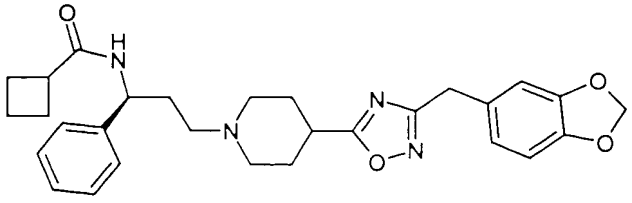
The title compound of preparation 78 (221mg, 0.54mmol) in dichloromethane (10ml) was treated with trifluoroacetic acid (4ml). The solution was stirred at room temperature for 12 hours. The solvent was evaporated under reduced pressure and the residue was partitioned between saturated aqueous sodium carbonate solution and dichloromethane. The aqueous layer was extracted with dichloromethane (2x). The combined organic layers were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue obtained (164mg, 0.53mmol), the title compound of preparation 8 (134mg, 0.58mmol) and sodium triacetoxyborohydride (168mg, 0.70mmol) were stirred in dichloromethane:acetic acid (20ml, 10%) at room temperature for 3 days. The reaction mixture was basified with saturated aqueous sodium carbonate solution. The aqueous layer was extracted with dichloromethane (2x) and the combined organic extracts washed with brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by preparative HPLC (phenomonex magellenC_{18} (2) aqueous TFA 0.1%:acetonitrile 1:19-19:1) to afford the title compound, 40mg.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.46-2.61 (13H, m), 2.61-3.25 (5H, m), 3.45 (1H, m), 3.72 (1H, m), 4.13 (2H, s), 4.95 (1H, m), 6.65 (1H, m), 7.13-7.45 (7H, m), 7.42 (1H, d), 7.58 (1H, d)

LRMS: m/z 527.4 (MH^+)

EXAMPLE 19

N-((1*S*)-3-{4-[3-(1,3-Benzodioxol-5-ylmethyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)cyclobutanecarboxamide (UK-383290-51)



The title compound of preparation 79 (258mg, 0.67mmol) in dichloromethane (10ml) was treated with trifluoroacetic acid (4ml). The solution was stirred at room temperature for 12 hours. The solvent was evaporated under reduced pressure and the residue was partitioned between saturated aqueous sodium carbonate solution and dichloromethane. The aqueous layer was extracted with dichloromethane (2x). The combined organic layers were dried

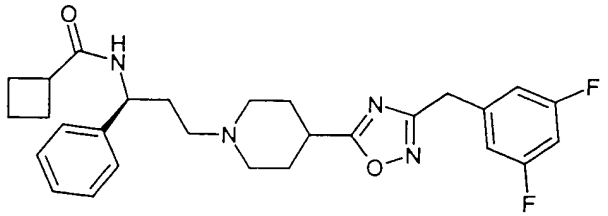
($MgSO_4$), filtered and evaporated under reduced pressure. The residue obtained (175mg, 0.44mmol), the title compound of preparation 8 (113mg, 0.49mmol) and sodium triacetoxyborohydride (141mg, 0.66mmol) were stirred in dichloromethane:acetic acid (20ml, 10%) at room temperature for 3 days. The reaction mixture was basified with saturated aqueous sodium carbonate solution. The aqueous layer was extracted with dichloromethane (2x) and the combined organic extracts washed with brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by preparative HPLC (phenomonex magellenC_{18} (2) aqueous TFA 0.1%:acetonitrile 1:19-19:1) to afford the title compound, 31mg.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.74-3.35 (18H, m), 3.46 (1H, m), 3.70 (1H, m), 3.96 (2H, s), 4.90 (1H, m), 4.95 (1H, m), 5.95 (2H, s), 6.65-6.85 (3H, m), 7.25-7.51 (5H, m)

LRMS: m/z 503.4 (MH^+)

EXAMPLE 20

N-((1*S*)-3-{4-[3-(3,5-Difluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)cyclobutanecarboxamide



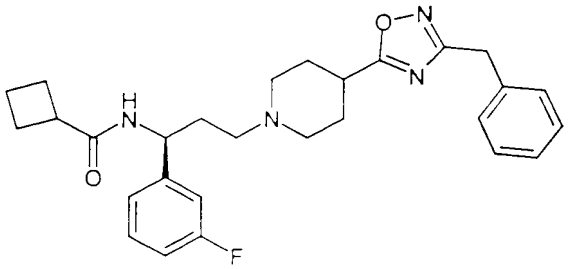
The title compound of preparation 75 (100mg, 0.26mmol) in dichloromethane (10ml) was treated with trifluoroacetic acid (4ml). The solution was stirred at room temperature for 12 hours. The solvent was evaporated under reduced pressure and the residue was partitioned between saturated aqueous sodium carbonate solution and dichloromethane. The aqueous layer was extracted with dichloromethane (2x). The combined organic layers were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue obtained (69mg, 0.25mmol), the title compound of preparation 8 (63mg, 0.27mmol) and sodium triacetoxyborohydride (79mg, 0.37mmol) were stirred in dichloromethane:acetic acid (20ml, 10%) at room temperature for 3 days. The reaction mixture was basified with saturated aqueous sodium carbonate solution. The aqueous layer was extracted with dichloromethane (2x) and the combined organic extracts washed with brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by preparative HPLC (phenomonex magellenC_{18} (2) aqueous TFA 0.1%:acetonitrile 1:19-19:1) to afford the title compound, 39mg.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.74-3.35 (18H, m), 3.45 (1H, m), 3.70 (1H, m), 4.04 (2H, s), 4.93 (1H, m), 6.65-6.91 (3H, m), 7.23-7.45 (6H, m)

LRMS: m/z 495.0 (MH^+)

EXAMPLE 21

N-[(1*S*)-3-[4-(3-Benzyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-(3-fluorophenyl)propyl]cyclobutanecarboxamide



Diisobutylaluminium hydride (42.1ml of a 1.0M solution in dichloromethane, 42.1mmol) was added dropwise to a solution of the title compound of preparation 12 (5.7g, 19.1mmol) in dichloromethane (100ml) at -78°C. The reaction mixture was stirred at 78°C for an hour, then methanol (5ml) pre-cooled to -78°C was added. The mixture was warmed to room temperature and washed with 2M hydrochloric acid, water and brine, dried ($MgSO_4$), filtered and the solvent evaporated under reduced pressure to afford the title compound as a yellow oil, 3.3g. From this oil (485mg, 1.81mmol), the title compound of preparation 39 (420mg, 1.81mmol) and sodium triacetoxyborohydride (578mg, 2.73mmol) were stirred together for 72 hours at room temperature in dichloromethane:acetic acid (30ml, 10%). The solvents were evaporated under reduced pressure. The residue was dissolved in ethyl acetate and washed with saturated aqueous sodium carbonate solution then water. The organic layer was dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue (700mg, 1.42mmol) was stirred for 1 hour at room temperature in dichloromethane (14ml) and trifluoroacetic acid (14ml). The solvents were evaporated under reduced pressure. The residue was basified with saturated aqueous sodium carbonate solution and extracted with dichloromethane (3x). The combined organic layers were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using dichlorormethane:methanol:0.88 ammonia (97:3:0.3) as eluant. A portion of the residue (100mg, 0.25mmol), cyclobutanecarboxylic acid (28mg, 0.28mmol), 1-hydroxybenzotriazole hydrate (41mg, 0.3mmol), 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (63mg, 0.33mmol) and triethylamine (46µl, 0.33mmol) were stirred for 2 hours at room temperature in dichloromethane (20ml). The solvent was evaporated under reduced pressure. The residue was dissolved in ethyl acetate and washed with water. The organic layer was dried ($MgSO_4$), filtered and evaporated. The residue was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia

(98:2:0.25) as eluant to afford the title compound as a gum which solidified on standing, 108mg.

Found C, 70.26; H, 7.00; N, 11.66%

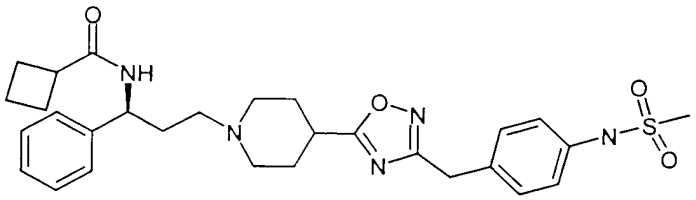
$C_{28}H_{33}FN_4O_2;0.1H_2O$ requires C, 70.30; H, 7.00; N, 11.71%

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.31-2.44 (14H, m), 2.80-3.10 (5H, m), 4.02-4.15 (3H, m), 5.06-5.18 (1H, m), 6.84-7.03 (4H, m), 7.18-7.42 (5H, m), 7.71-7.84 (1H, m)

LRMS: m/z 477.3 (MH^+)

EXAMPLE 22

N-{(1*S*)-3-[4-(3-{4-[(Methylsulfonyl)amino]benzyl}-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide



The title compound of preparation 47 (6.50g, 30.9mmol), hydroxylamine hydrochloride (10.7g, 154mmol) and sodium carbonate (16.3g, 154mmol) in methanol (100ml) and water (100ml) were heated under reflux for 5 hours. The reaction was cooled, filtered and the methanol evaporated under reduced pressure. The remaining aqueous layer was extracted with dichloromethane (3x) and the combined organic layers were dried ($MgSO_4$), filtered and the solvent evaporated under reduced pressure to furnish a pale orange solid. The solid and carbonyldiimidazole (158mg, 0.97mmol) were then added to a solution of carbonyldiimidazole (158mg, 0.97mmol) and the title compound of preparation 115 in DMF (2ml) which had been stirred at room temperature for 1 hour. The reaction was heated at 115°C for 6 hours cooled to room temperature and the solvent evaporated under reduced pressure. The resulting brown oil was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford the title compound as a pale orange oil that was freeze dried from water/acetonitrile to furnish a pale orange foam, 43mg.

Found C, 62.23; H, 6.82; N, 12.60%

$C_{29}H_{37}N_5SO_4;0.3H_2O$ requires C, 62.52; H, 6.80; N, 12.57%

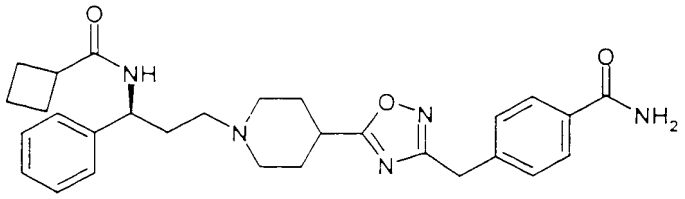
^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.78-2.40 (18H, m), 2.80-3.05 (7H, m), 4.03 (2H, s), 5.08 (1H, dd), 7.15-7.45 (9H, m)

LRMS: m/z 552 (MH^+)

$[\alpha]_D$ -32.6 (c=1.97, MeOH)

EXAMPLE 23

4-{[5-(1-{(3*S*)-3-[(Cyclobutylcarbonyl)amino]-3-phenylpropyl}-4-piperidinyl)-1,2,4-oxadiazol-3-yl]methyl}benzamide



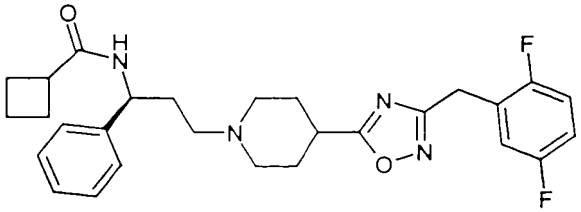
The title compound of preparation 55 (7.00g, 43.8mmol), hydroxylamine hydrochloride (15.2g, 218mmol) and sodium carbonate (23.1g, 218mmol) in methanol (100ml) and water (100ml) were heated under reflux for 5 hours. The reaction was cooled, filtered and the methanol evaporated under reduced pressure. The remaining aqueous layer was extracted with dichloromethane (3x) and the combined organic layers were dried ($MgSO_4$), filtered and the solvent evaporated under reduced pressure to furnish a pale orange solid. The solid and carbonyldiimidazole (158mg, 0.97mmol) were then added to a solution of carbonyldiimidazole (158mg, 0.97mmol) and the title compound of preparation 115 in DMF (2ml) which had been stirred at room temperature for 1 hour. The reaction was heated at 115°C for 6 hours allowed to cool to room temperature and the solvent evaporated under reduced pressure. The resulting brown oil was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford the title compound as a clear oil that was freeze dried from water/acetonitrile to furnish a white solid, 12mg.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.78-2.40 (17H, m), 2.80-3.05 (4H, m), 4.03 (2H, s), 5.08 (1H, dd), 5.58 (1H, br s), 6.01 (1H, br s), 7.15-7.30 (5H, m), 7.40 (2H, d), 7.75 (2H, d)

LRMS: m/z 502 (MH^+)

EXAMPLE 24

N-((1*S*)-3-{4-[3-(2,5-Difluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)cyclobutanecarboxamide



The title compound of preparation 74 (142mg, 0.37mmol) in dichloromethane (10ml) was treated with trifluoroacetic acid (4ml) and the solution stirred at room temperature for 12 hours. The solvent was evaporated under reduced pressure and the residue was partitioned between saturated aqueous sodium carbonate solution and dichloromethane. The aqueous layer was extracted with dichloromethane (2x). The combined organic layers were dried

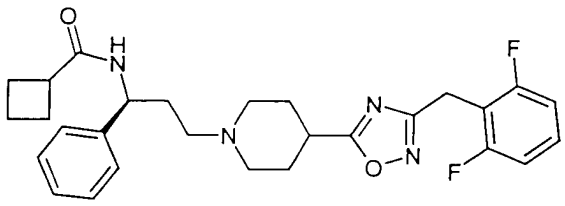
($MgSO_4$), filtered and evaporated under reduced pressure. The residue obtained (107mg, 0.38mmol), the title compound of preparation 8 (97mg, 0.42mmol) and sodium triacetoxyborohydride (122mg, 0.59mmol) were stirred in dichloromethane:acetic acid (20ml, 10%) at room temperature for 3 days. The reaction mixture was basified with saturated aqueous sodium carbonate solution. The aqueous layer was extracted with dichloromethane (2x) and the combined organic extracts washed with brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by preparative HPLC (phenomonex magellenC_{18} (2) aqueous TFA 0.1%:acetonitrile 1:19-19:1) to afford the title compound, 9mg.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.43-2.05 (4H, m), 2.05-2.41 (8H, m), 2.50 (1H, bs), 2.66-2.83 (1H, m), 2.85-3.36 (4H, m), 3.45 (1H, m), 3.70 (1H, bs), 4.08 (2H, s), 4.95 (1H, s), 6.70 (1H, bs), 6.93-7.14 (2H, m), 7.27-7.41 (6H, m)

LRMS: m/z 495.1 (MH^+)

EXAMPLE 25

N-((1*S*)-3-{4-[3-(2,6-Difluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)cyclobutanecarboxamide



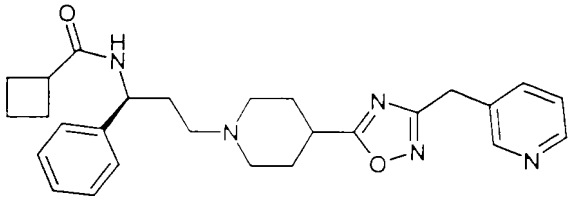
The title compound of preparation 76 (163mg, 0.43mmol) in dichloromethane (10ml) was treated with trifluoroacetic acid (4ml) and the solution stirred at room temperature for 12 hours. The solvent was evaporated under reduced pressure and the residue was partitioned between saturated aqueous sodium carbonate solution and dichloromethane. The aqueous layer was extracted with dichloromethane (2x). The combined organic layers were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue obtained (118mg, 0.42mmol), the title compound of preparation 8 (107mg, 0.47mmol) and sodium triacetoxyborohydride (143mg, 0.63mmol) were stirred in dichloromethane:acetic acid (20ml, 10%) at room temperature for 3 days. The reaction mixture was basified with saturated aqueous sodium carbonate solution. The aqueous layer was extracted with dichloromethane (2x) and the combined organic extracts washed with brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by preparative HPLC (phenomonex magellenC_{18} (2) aqueous TFA 0.1%:acetonitrile 1:19-19:1) to afford the title compound, 10mg.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.33-2.05 (4H, m), 2.05-2.45 (8H, m), 2.41-2.82 (2H, m), 2.86-3.25 (4H, m), 3.35-3.87 (2H, m), 4.15 (2H, s), 4.95 (1H, s), 6.85 (1H, m), 6.95 (2H, m), 7.23-7.45 (6H, m)

LRMS: m/z 495.1 (MH^+)

EXAMPLE 26

N-((1*S*)-1-Phenyl-3-{4-[3-(3-pyridinylmethyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}propyl)cyclobutanecarboxamide



A solution of the title compound of preparation 115 (300mg, 0.87mmol) in dichloromethane (20ml) was treated with diisopropylethylamine (0.36ml, 2.09mmol) and bis(tetramethylene)fluoroformamidinium hexafluorophosphate (331mg, 1.05mmol). After 1 hour *N*'-hydroxy-2-(3-pyridinyl)ethanimidamide [WO 9600720] (171mg, 1.13mmol) was added and stirring continued for 12 hours. The reaction was diluted with dioxane (30ml) then heated at 120°C for 4 hours. The cooled mixture was diluted with dichloromethane (100ml) and washed with saturated aqueous sodium carbonate solution and brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure. The crude product was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (94.5:5:0.5) as eluant. The resultant oil was dissolved in dichloromethane (10ml), treated with 1M hydrochloric acid in dioxane (4ml) and evaporated under reduced pressure. Freeze drying from water/acetonitrile gave the title compound as a yellow solid, 191mg.

Found C, 51.85; H, 7.06; N, 11.02%

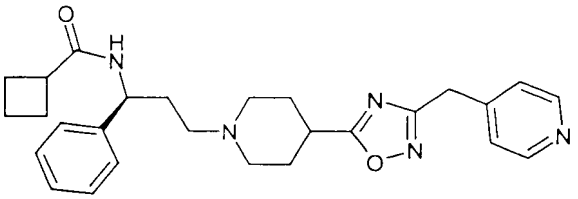
$C_{27}H_{33}N_5O_2$;5H_2O;2HCl requires C, 52.09; H, 7.29; N, 11.25%

^{1}H NMR (400MHz, DMSOd6): δ [ppm] 1.70 (1H, m), 1.86 (1H, m), 1.92-2.14 (10H, m), 2.91-3.17 (5H, m), 3.28-4.02 (2H and H_2O), 4.36 (2H, s), 4.83 (1H, m), 7.22 (1H, m), 7.30 (3H, m), 7.94 (1H, m), 8.24 (1H, d), 8.41(1H, d), 8.78 (1H, d), 8.88 (1H, s)

LRMS: m/z 460.2 (MH^+)

EXAMPLE 27

N-((1*S*)-1-Phenyl-3-{4-[3-(4-pyridinylmethyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}propyl)cyclobutanecarboxamide



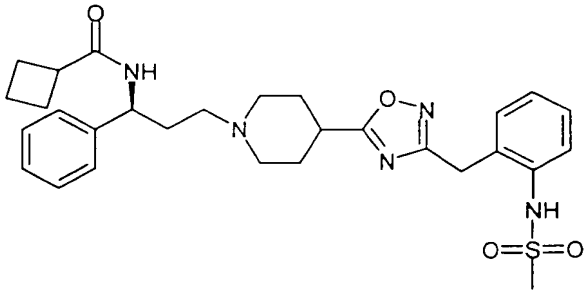
A solution of the title compound of preparation 115 (300mg, 0.87mmol) in dichloromethane (20ml) was treated with diisopropylethylamine (0.36ml, 2.09mmol) and bis(tetramethylene)fluoroformamidinium hexafluorophosphate (331mg, 1.05mmol). After 1 hour *N'*-hydroxy-2-(4-pyridinyl)ethanimidamide [WO 9600720] (171mg, 1.13mmol) was added and stirring continued for 12 hours. The reaction was diluted with dioxane (30ml) then heated at 120°C for 4 hours. The cooled mixture was diluted with dichloromethane (100ml) and washed with saturated aqueous sodium carbonate solution and brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure. The crude product was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (94.5:5:0.5) as eluant. Freeze-drying from water/acetonitrile gave the title compound as a yellow foam, 121mg.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.75-2.20 (12H, m), 2.20-2.40 (4H, m), 2.80-3.10 (4H, m), 4.05 (2H, s), 5.14 (1H, m), 7.16-7.37(8H, m), 8.57 (1H, d)

LRMS: m/z 460.2 (MH^+)

EXAMPLE 28

N-{(1*S*)-3-[4-(3-{2-[(Methylsulfonyl)amino]benzyl}-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide



The title compound of preparation 48 (5.60g, 28.5mmol), hydroxylamine hydrochloride (9.9g, 142mmol) and sodium carbonate (15.1g, 142mmol) in methanol (100ml) and water (100ml) were heated under reflux for 5 hours. The reaction was cooled, filtered and the methanol evaporated under reduced pressure. The remaining aqueous was extracted with dichloromethane (3x) and the combined organic layers dried ($MgSO_4$), filtered evaporated under reduced pressure to furnish a red solid. The solid and carbonyldiimidazole (158mg, 0.97mmol) were then added to a solution of carbonyldiimidazole (158mg, 0.97mmol) and the

title compound of preparation 115 in DMF (2ml) which had been stirred at room temperature for 1 hour. The reaction was heated at 115°C for 6 hours cooled to room temperature and the solvent evaporated under reduced pressure, the resulting brown oil was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford the title compound as a clear oil that was freeze dried from water/acetonitrile to furnish a white solid, 24mg.

Found C, 62.83; H, 6.84; N, 12.95%

$C_{29}H_{37}N_5SO_4$;0.1H_2O requires C, 62.93; H, 6.77; N, 12.65%

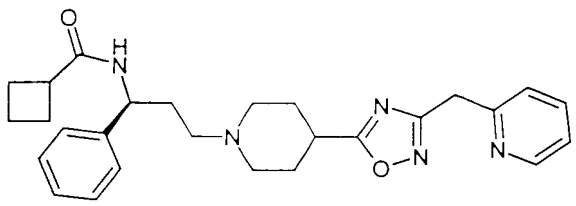
^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.80-2.40 (17H, m), 2.80-3.05 (4H, m), 3.11 (3H, s), 4.08 (2H, s), 5.05 (1H, dd), 7.15-7.45 (8H, m), 7.60 (1H, d), 9.73 (1H, bs)

LRMS: m/z 552 (MH^+)

$[\alpha]_D$ -31.0 (c=1.16, MeOH)

EXAMPLE 29

N-((1*S*)-1-Phenyl-3-{4-[3-(2-pyridinylmethyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}propyl)cyclobutanecarboxamide



A solution of the title compound of preparation 115 (300mg, 0.87mmol) in dichloromethane (20ml) was treated with diisopropylethylamine (0.36ml, 2.09mmol) and bis(tetramethylene)fluoroformamidinium hexafluorophosphate (331mg, 1.05mmol). After 1 hour *N*'-hydroxy-2-(2-pyridinyl)ethanimidamide [WO 9600720] (171mg, 1.13mmol) was added and stirring continued for 12 hours. The reaction was diluted with dioxane (30ml) then heated at 120°C for 4 hours. The cooled mixture was diluted with dichloromethane (100ml) and washed with saturated aqueous sodium carbonate solution and brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure. The crude product was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (94.5:5:0.5) as eluant. The resulting oil was dissolved in dichloromethane (10ml), treated with 1M hydrochloric acid in dioxane (4ml) and evaporated under reduced pressure. Freeze-drying from water/acetonitrile gave the title compound as a green gum, 95mg.

Found C, 52.25; H, 6.97; N, 11.14%

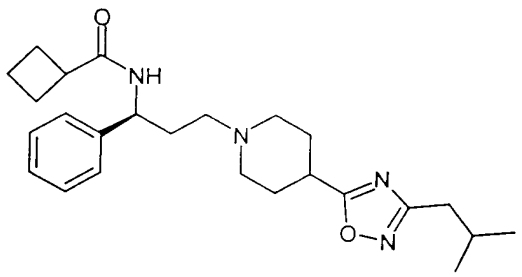
$C_{27}H_{33}N_5O_2$;4.9H_2O;2HCl requires C, 52.24; H, 7.27; N, 11.28%

^{1}H NMR (400MHz, DMSOD6): δ [ppm] 1.72 (1H, m); 1.86 (1H, m); 1.9-2.1 (10H, m); 2.9-3.1 (5H, m); 3.2-4.0 (2H and H_2O); 4.45 (2H, s); 4.83 (1H, m); 7.23 (1H, m); 7.30 (3H, m); 7.65 (1H, t); 7.70 (1H, d); 8.15 (1H, t); 8.23 (1H, d); 8.67 (1H, d)

LRMS: m/z 460.2 (MH^+)

EXAMPLE 30

N-{(1*S*)-3-[4-(3-Isobutyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide



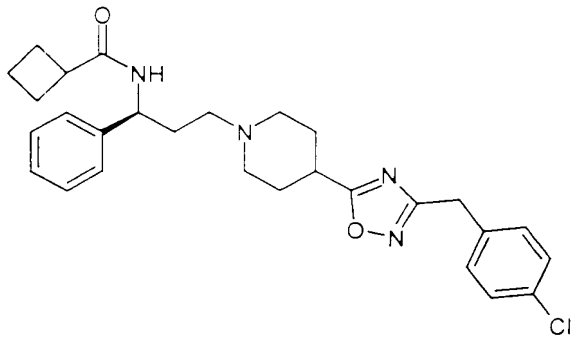
The title compound of preparation 73 (305mg, 0.98mmol) in dichloromethane (10ml) was treated with trifluoroacetic acid (4ml) and solution stirred at room temperature for 12 hours. The solvent was evaporated under reduced pressure and the residue was partitioned between saturated aqueous sodium carbonate solution and dichloromethane. The aqueous layer was extracted with dichloromethane (2x). The combined organic layers were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue obtained (161mg, 0.76mmol), the title compound of preparation 8 (213mg, 0.923mmol) and sodium triacetoxyborohydride (244mg, 1.15mmol) were stirred in dichloromethane:acetic acid (20ml, 10%) at room temperature for 2 weeks. The reaction mixture was basified with saturated aqueous sodium carbonate solution. The aqueous layer was extracted with dichloromethane (2x) and the combined organic extracts washed with brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by preparative HPLC (phenomonex magellenC_{18} (2) aqueous TFA 0.1%:acetonitrile 1:19-19:1) to afford the title compound, 52mg.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 0.95 (6H, d), 1.80-2.20 (13H, m), 2.22-2.40 (4H, m), 2.60 (2H, d), 2.90 (2H, m), 3.05 (2H, m), 5.10 (1H, m), 7.20 (3H, d), 7.30 (2H, m), 7.50 (1H, d)

LRMS: m/z 425 (MH^+)

EXAMPLE 31

N-((1*S*)-3-{4-[3-(3-Chlorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)cyclobutanecarboxamide



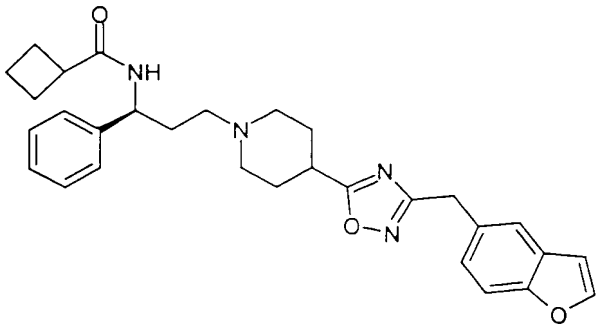
The title compound of preparation 72 (260mg, 0.68mmol) in dichloromethane (10ml) was treated with trifluoroacetic acid (4ml) and the solution stirred at room temperature for 12 hours. The solvent was evaporated under reduced pressure and the residue was partitioned between saturated aqueous sodium carbonate solution and dichloromethane. The aqueous layer was extracted with dichloromethane (2x). The combined organic layers were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue obtained (145mg, 0.52mmol), the title compound of preparation 8 (145mg, 0.62mmol) and sodium triacetoxyborohydride (166mg, 0.78mmol) were stirred in dichloromethane:acetic acid (20ml, 10%) at room temperature for 2 weeks. The reaction mixture was basified with saturated aqueous sodium carbonate solution. The aqueous layer was extracted with dichloromethane (2x) and the combined organic extracts washed with brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by preparative HPLC (phenomonex magellenC_{18} (2) aqueous TFA 0.1%:acetonitrile 1:19-19:1) to afford the title compound, 9mg.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.82-2.00 (4H, m), 2.00-2.22 (8H, m), 2.25-2.32 (4H, m), 3.00 (4H, m), 4.02 (2H, s), 5.05 (1H, m), 7.20-7.35 (9H, m), 7.38 (1H, d)

LRMS: m/z 494 (MH^+)

EXAMPLE 32

N-((1*S*)-3-{4-[3-(1-Benzofuran-5-ylmethyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)cyclobutanecarboxamide



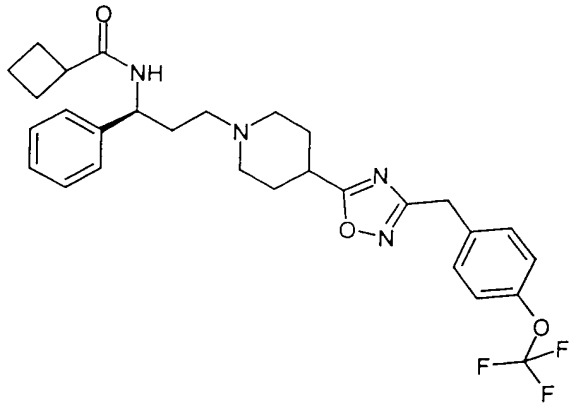
The title compound of preparation 71 (176mg, 0.45mmol) in dichloromethane (10ml) was treated with trifluoroacetic acid (4ml) and the solution stirred at room temperature for 12 hours. The solvent was evaporated under reduced pressure and the residue was partitioned between saturated aqueous sodium carbonate solution and dichloromethane and the aqueous layer extracted with dichloromethane (2x). The combined organic layers were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue obtained (130mg, 0.45mmol), the title compound of preparation 8 (127mg, 0.55mmol) and sodium triacetoxyborohydride (146mg, 0.68mmol) were stirred in dichloromethane:acetic acid (20ml, 10%) at room temperature for 2 weeks. The reaction mixture was basified with saturated aqueous sodium carbonate solution. The aqueous layer was extracted with dichloromethane (2x) and the combined organic extracts washed with brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by preparative HPLC (phenomonex magellenC_{18} (2) aqueous TFA 0.1%:acetonitrile 1:19-19:1) to afford the title compound, 44mg.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.82-2.00 (5H, m), 2.00 (2H, s), 2.05-2.30 (8H, m), 2.40 (2H, m), 2.90 (2H, m), 3.05 (1H, m), 4.10 (2H, s), 5.05 (1H, m), 5.25 (1H, bs), 6.70 (1H, s), 7.20 (3H, m), 7.30 (2H, m), 7.40 (1H, d), 7.42 (1H, d), 7.58 (2H, d)

LRMS: m/z 499 (MH^+)

EXAMPLE 33

N-[(1*S*)-1-Phenyl-3-{4-{3-[4-(trifluoromethoxy)benzyl]-1,2,4-oxadiazol-5-yl}-1-piperidinyl)propyl]cyclobutanecarboxamide



The title compound of preparation 70 (306mg, 0.71mmol) in dichloromethane (10ml) was treated with trifluoroacetic acid (4ml) and the solution stirred at room temperature for 12 hours. The solvent was evaporated under reduced pressure and the residue was partitioned between saturated aqueous sodium carbonate solution and dichloromethane and the aqueous layer extracted with dichloromethane (2x). The combined organic layers were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue obtained (204mg, 0.62mmol), the title compound of preparation 8 (173mg, 0.74mmol) and sodium triacetoxyborohydride

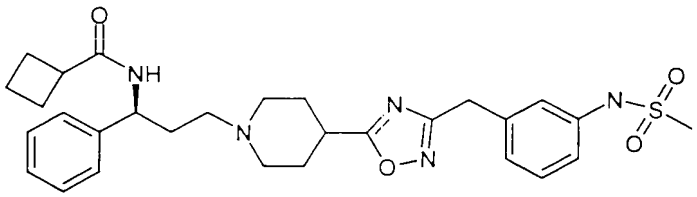
(198mg, 0.93mmol) were stirred in dichloromethane:acetic acid (20ml, 10%) at room temperature for 2 weeks. The reaction mixture was basified with saturated aqueous sodium carbonate solution. The aqueous layer was extracted with dichloromethane (2x) and the combined organic extracts washed with brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by preparative HPLC (phenomonex magellenC_{18} (2) aqueous TFA 0.1%:acetonitrile 1:19-19:1) to afford the title compound, 38mg.

^{1}H NMR (400MHz, $CDCl_3$): δ [ppm] 1.81-2.30 (14H, m), 2.40 (2H, m), 2.92 (2H, m), 3.05 (2H, m), 4.05 (2H, s), 5.05 (2H, m), 7.18 (2H, d), 7.22 (3H, m), 7.32 (4H, m)

LRMS: m/z 543 (MH^+)

EXAMPLE 34

N-{(1*S*)-3-[4-(3-{3-[(Methylsulfonyl)amino]benzyl}-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide



To a solution of the title compound of preparation 66 (220mg, 0.91mmol) in dichloromethane (10ml) was added the title compound of preparation 115 (340mg, 0.99mmol), 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (210mg, 1.09mmol) and triethylamine (1.08ml, 7.12mmol). The reaction was stirred at room temperature for 18 hours then water was added and the layers separated. The organic layer was washed with brine, dried ($MgSO_4$) and evaporated under reduced pressure. Toluene (25ml) was added and the solution was heated under reflux for 5 hours. The reaction mixture was cooled and evaporated under reduced pressure. The crude material was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford the title compound as a brown oil. This was freeze dried from water/acetonitrile to give the title compound as a brown foam, 100mg.

Found C, 62.37; H, 6.92; N, 12.29%

$C_{29}H_{37}H_5O_4S;0.4H_2O$ requires C, 62.32; H, 6.82; N, 12.53%

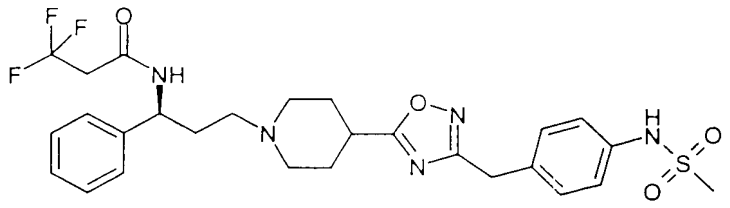
^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.79-1.99 (5H, m), 2.00-2.19 (8H, m), 2.20-2.40 (4H, m), 2.82-3.09 (7H, m), 3.42 (1H, m), 4.02 (2H, s), 5.09-5.17 (1H, m), 7.10-7.41 (9H, m)

LRMS: m/z 552.1 (MH^+)

$[\alpha]_D$ -45.3 (c = 2.12, methanol)

EXAMPLE 35

3,3,3-Trifluoro-*N*-{(1*S*)-3-[4-(3-{4-[(methylsulfonyl)amino]benzyl}-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}propanamide



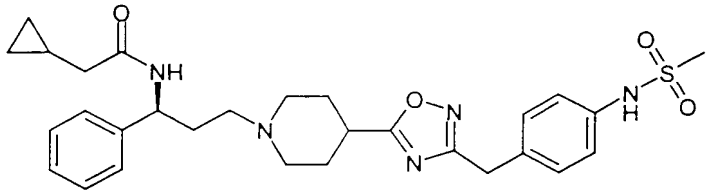
1-(3-Dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (49mg, 0.25mmol) was added to a stirred solution of 3,3,3-trifluoropropionic acid (29mg, 0.23mmol) and the title compound of preparation 91 (100mg, 0.21mmol) in dichloromethane (10ml). After 1 hour the reaction mixture was loaded directly onto a column of silica and eluted with dichloromethane: methanol:0.88 ammonia (95:5:0.5) to afford the title compound as a white foam, 55mg.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.73-2.35 (12H, m), 2.81-3.18 (8H, m), 4.03 (2H, s), 5.12 (1H, dd), 7.05-7.19 (8H, m), 8.34 (1H, d)

LRMS: m/z 580 (MH^+)

EXAMPLE 36

2-Cyclopropyl-*N*-{(1*S*)-3-[4-(3-{4-[(methylsulfonyl)amino]benzyl}-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}acetamide



1-(3-Dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (49mg, 0.25mmol) was added to a stirred solution of cyclopropylacetic acid (24mg, 0.23mmol) and the title compound of preparation 91 (100mg, 0.21mmol) in dichloromethane (10ml). After 1 hour the reaction mixture was loaded directly onto a column of silica and eluted with dichloromethane:methanol:0.88 ammonia (95:5:0.5) to afford the title compound as a white foam, 75mg.

Found C, 62.06; H, 6.83; N, 12.49%

$C_{29}H_{37}N_5SO_4$;0.5H_2O requires C, 62.12; H, 6.83; N, 12.49%

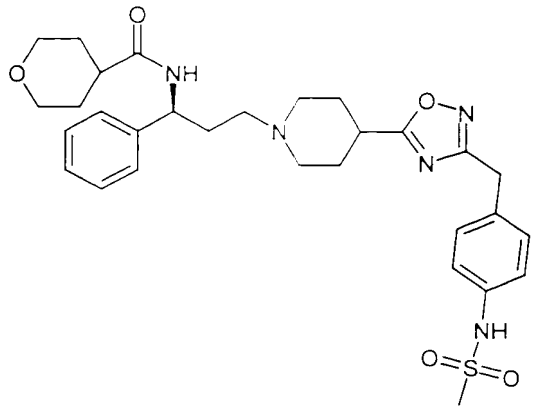
^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 0.20 (2H, m), 0.58 (2H, m), 1.01 (1H, m), 1.81-2.00 (3H, m), 2.03-2.19 (7H, m), 2.21-2.43 (2H, m), 2.98 (6H, m), 4.02 (2H, s), 5.11 (1H, dd), 7.09-7.38 (9H, m)

LRMS: m/z 552 (MH^+)

$[\alpha]_D$ -90.0 (c = 1.00, MeOH)

EXAMPLE 37

N-{(1*S*)-3-[4-(3-{4-[(Methylsulfonyl)amino]benzyl}-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}tetrahydro-2*H*-pyran-4-carboxamide



1-(3-Dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (49mg, 0.25mmol) was added to a stirred solution of the title compound of preparation 17 (30mg, 0.23mmol) and the title compound of preparation 91 (100mg, 0.21mmol) in dichloromethane (10ml). After 1 hour the reaction mixture was loaded directly onto a column of silica and eluted with dichloromethane:methanol:0.88 ammonia (95:5:0.5) to afford the title compound as a white foam, 45mg.

Found C, 59.39; H, 6.73; N, 11.21%

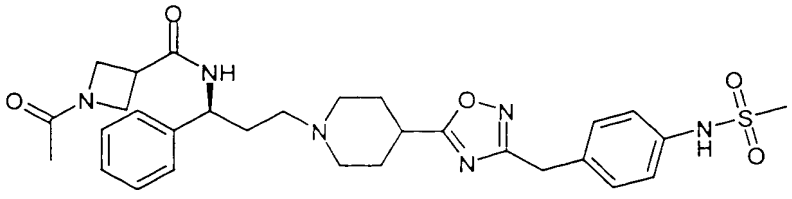
$C_{30}H_{39}N_5SO_5$;1.5H_2O requires C, 59.19; H, 6.95; N, 11.50%

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.71-2.15 (14H, m), 2.18-2.50 (3H, m), 2.84-3.12 (6H, m), 3.38 (2H, m), 3.89-4.09 (4H, m), 5.09 (1H, dd), 7.09-7.39 (8H, m), 7.81 (1H, d)

LRMS: m/z 582 (MH^+)

EXAMPLE 38

1-Acetyl-*N*-{(1*S*)-3-[4-(3-{4-[(methylsulfonyl)amino]benzyl}-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}-3-azetidinecarboxamide



To a solution of the title compound of preparation 91 (100mg, 0.21mmol) in dichloromethane (3ml) was added the title compound of preparation 14 (35mg, 0.23mmol) and 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (50mg, 0.25mmol). The reaction was stirred at room temperature for 1 hour. The crude material was purified by

column chromatography on silica gel, using dichloromethane:methanol:0.88 ammonia (90:10:1) as eluant to afford the title compound as a white foam, 102mg.

Found C, 59.51; H, 6.59; N, 13.71%

$C_{30}H_{38}N_6O_5$;0.6H_2O requires C, 59.51; H, 6.53; N, 13.88%

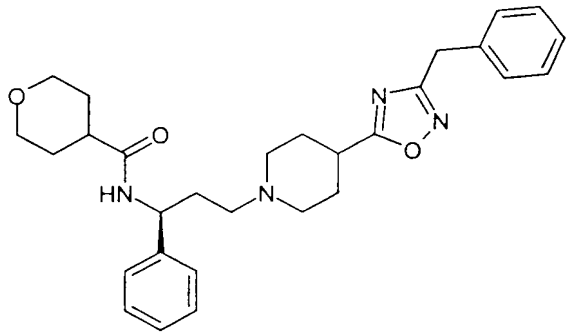
^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.69-2.20 (10H, m), 1.88 (3H, s), 2.25-2.35 (1H, m), 2.38-2.49 (1H, m), 2.81-3.10 (6H, m), 3.18-3.23 (1H, m), 4.05 (2H, s), 4.10-4.20 (3H, m), 4.38-4.45 (1H, m), 5.10-5.19 (1H, m), 7.17-7.38 (8H, m), 8.02-8.10 (0.5H, m), 8.30-8.39 (0.5H, m)

LRMS: m/z 595.2 (MH^+)

$[\alpha]_D$: -33.2 (c = 1.93, methanol)

EXAMPLE 39

N-{(1*S*)-3-[4-(3-Benzyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}tetrahydro-2*H*-pyran-4-carboxamide



The title compound of preparation 81 (77mg, 0.20mmol), the title compound of preparation 17 (26mg, 0.20mmol) and 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (51mg, 0.26mmol) were stirred in dichloromethane (10 ml) at room temperature for 2 hours. The reaction mixture was then washed with brine (2×), dried ($MgSO_4$), filtered and concentrated under reduced pressure. The residue was purified by column chromatography on silica gel using dichlormethane:methanol (95:5) as eluant to afford the title compound as a white solid, 57mg.

Found C, 69.85; H, 7.45; N, 11.11%

$C_{29}H_{36}N_4O_3$;1H_2O, requires C, 71.30; H, 7.40; N 11.50%

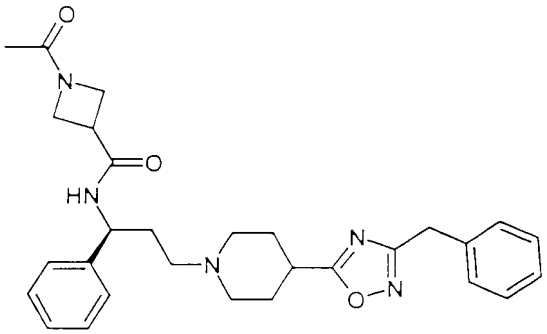
^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.80-2.10 (12H, m), 2.20-2.40 (3H, m), 2.90 (2H, m), 3.05 (1H, d), 3.40 (2H, m), 4.00 (2H, m), 4.05 (2H, s), 5.10 (1H, m), 7.20-7.35 (10H, m), 7.90 (1H, d)

LRMS: m/z 489 (MH^+)

$[\alpha]_D$ -32 (c = 1.0, MeOH)

EXAMPLE 40

1-Acetyl-*N*-{(1*S*)-3-[4-(3-benzyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}-3-azetidinecarboxamide



The title compound of preparation 81 (58mg, 0.15mmol), the title compound of preparation 14 (33mg, 0.23mmol) and 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (44mg, 0.23mmol) were stirred in dichloromethane (10 ml) at room temperature for 2 hours. The reaction mixture was then washed with brine (2×), dried ($MgSO_4$), filtered and concentrated under reduced pressure. The residue was purified by column chromatography on silica gel using dichlormethane:methanol (95:5) as eluant to afford the title compound as a white solid, 23mg.

Found: C, 66.88; H, 7.25; N, 13.45%

$C_{29}H_{35}N_5O_3;1H_2O$ requires C, 69.44; H, 7.03; N 13.96%

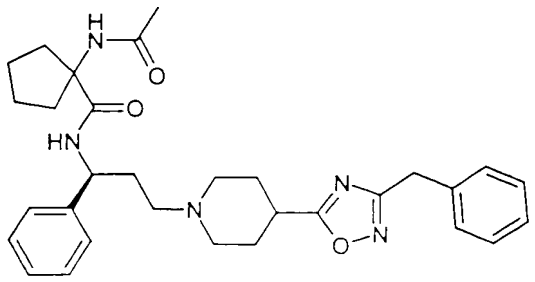
^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.85 (3H, s), 1.90-2.40 (10H, m), 2.90-3.00 (2H, m), 3.20 (1H, m), 4.05 (2H, s), 4.18 (4H, m), 4.40 (1H, m), 5.15 (1H, m), 7.20-7.35 (10H, m), 8.00-8.15 (1H, dd)

LRMS: m/z 502 (MH^+)

$[\alpha]_D$ -42 (c = 1.00, MeOH)

EXAMPLE 41

1-(Acetylamino)-*N*-{(1*S*)-3-[4-(3-benzyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}cyclopentanecarboxamide



The title compound of preparation 81 (58mg, 0.15mmol), 1-(acetylamino)cyclopentanecarboxylic acid [Bull. Soc. Chim. Fr., (1965), 2942] (26mg, 0.15mmol) and 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (38mg, 0.20mmol) were stirred in dichloromethane (10ml) at room temperature for 2 hours. The reaction mixture was then washed with brine (2×), dried ($MgSO_4$), filtered, then concentrated under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane:methanol (98:2) as eluant to afford the title compound as a white solid 42mg.

Found C, 68.37; H, 7.49; N, 12.78%

$C_{31}H_{39}N_5O_3;1H_2O$ requires C, 70.30; H, 7.42; N 13.2%

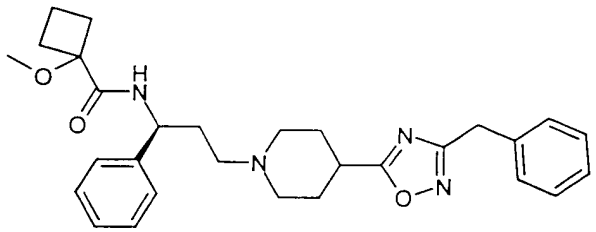
^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.90 (3H, s), 1.95-2.10 (14H, m), 2.30-2.35 (4H, m), 2.90 (2H, m), 2.95 (1H, m), 4.02 (2H, s), 5.05 (1H, m), 5.90 (1H, s), 7.20-7.30 (10H, m), 8.15 (1H, d)

LRMS: m/z 530 (MH^+)

$[\alpha]_D$ -36 (c = 1.0, MeOH)

EXAMPLE 42

N-{(1*S*)-3-[4-(3-Benzyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}-1-methoxycyclobutanecarboxamide



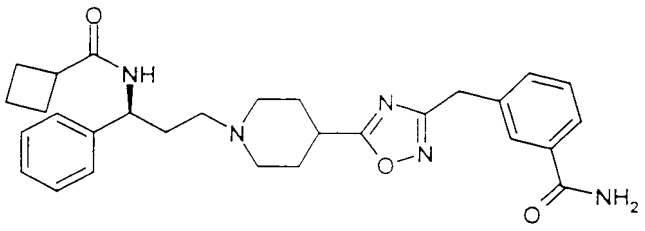
The title compound of preparation 81 (58mg, 0.15mmol), the title compound of preparation 19 (20mg, 0.15mmol) and 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (38mg, 0.20mmol) were stirred together in dichloromethane (10 ml) at room temperature for 2 hours. The reaction mixture was then washed with brine (2×), dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane:methanol (99:1) as eluant to afford the title compound as a yellow oil, 31mg.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.75-2.40 (16H, m), 2.85-2.95 (3H, m), 3.20 (3H, s), 4.05 (2H, s), 5.10 (1H, m), 7.20-7.35 (10H, m), 8.00 (1H, d)

LRMS: m/z 489.2 (MH^+)

EXAMPLE 43

3-{[5-(1-{(3S)-3-[(Cyclobutylcarbonyl)amino]-3-phenylpropyl}-4-piperidinyl)-1,2,4-oxadiazol-3-yl]methyl}benzamide



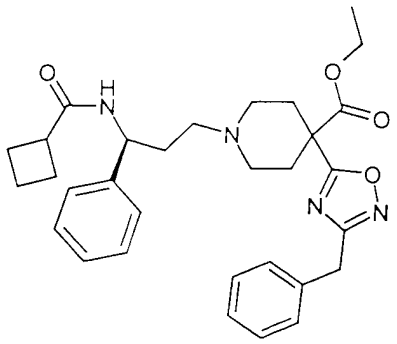
Oxalyl chloride (0.86ml, 9.90mmol) was added dropwise to a solution of the title compound of prepararion 52 (1.45g, 9.00mmol) in dichloromethane (20ml) and dimethylformamide (3 drops) at 0°C. The reaction was allowed to warm to room temperarure and stirred for 12 hours then 0.88 ammonia (1ml) was added cautiously, the solvent was evaporated under reduced pressure to furnish a yellow solid. The yellow solid was dissolved in methanol (30ml) and water (30ml) and hydroxylamine hydrochloride (3.15g, 45.0mmol) and sodium carbonate (4.77g, 45.0mmol) added. The reaction was heated under reflux for 5 hours, then cooled, filtered and the solvent evaporated under reduced pressure to give a yellow oil. The yellow oil was dissolved in dioxane (10ml) and the title compound from preparation 115 (344mg, 1.00mmol) and 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (210mg, 1.10mmol) were added and the reaction heated under reflux for 12 hours. The reaction was cooled and the solvent evaporated under reduced pressure. The resulting brown oil was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford the title compound as a white foam, 16mg.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.83-2.41 (16H, m), 2.80-3.09 (5H, m), 4.15 (2H, s), 5.08 (1H, dd), 5.71 (1H, bs), 6.18 (1H, bs), 7.19-7.58 (7H, m), 7.71 (1H, d), 7.80 (1H, s)

LRMS: m/z 502 (MH^+)

EXAMPLE 44

Ethyl 4-(3-benzyl-1,2,4-oxadiazol-5-yl)-1-{(3S)-3-[(cyclobutylcarbonyl)amino]-3-phenylpropyl}-4-piperidinecarboxylate



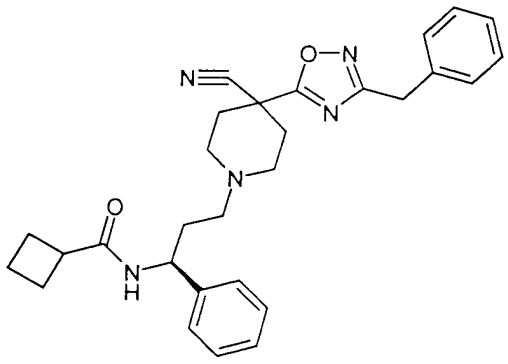
A suspension of the title compound of preparation 106 (195mg, 0.62mmol), the title compound of preparation 8 (215mg, 0.93mmol) and sodium triacetoxyborohydride (207mg, 0.93mmol) were stirred for 18 hours in dichloromethane:acetic acid (10ml, 10%) at room temperature, then washed with saturated aqueous sodium carbonate solution. The organic extract was separated, pre-adsorbed on silica gel, concentrated and purified by column chromatography on silica gel using ethyl acetate as eluant to afford the title compound as an oil, 170mg.

^{1}H NMR (300 MHz, CDCl3): δ [ppm] 1.16 (3H, t), 2.18 (19H, m) 3.00 (1H, m), 4.06 (2H, s), 4.15 (2H, q), 5.10 (1H, m), 7.24 (10H, m)

LRMS: m/z 531 (MH^+)

EXAMPLE 45

N-{(1*S*)-3-[4-(3-Benzyl-1,2,4-oxadiazol-5-yl)-4-cyano-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide



Sodium triacetoxyborohydride (294mg, 1.32mmol) was added to a solution of the title compound of preparation 107 (236mg, 0.88mmol) and the title compound of preparation 8 (305mg, 1.32mmol) in dichloromethane:acetic acid (10ml, 10%). The reaction mixture was stirred for 18 hours at room temperature, then partitioned between dichloromethane and saturated aqueous sodium carbonate solution. The organic extract was separated, concentrated under reduced pressure and purified by column chromatography on silica gel

using dichloromethane:methanol (95:5) as eluant to afford the title compound as a foam, 150mg.

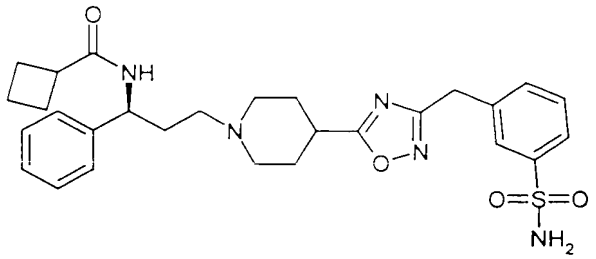
^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.93 (6H, m), 2.30 (9H, m), 2.93 (4H, m), 4.09 (2H, s), 5.10 (1H, dd), 6.48 (1H, d), 7.26 (10H, m)

LRMS: m/z 484.2 (MH^+)

$[\alpha]_D$ -38 (c = 1, methanol)

EXAMPLE 46

N-[(1*S*)-3-(4-{3-[3-(Aminosulfonyl)benzyl]-1,2,4-oxadiazol-5-yl}-1-piperidinyl)-1-phenylpropyl]cyclobutanecarboxamide



The title compound of preparation 115 (400mg, 1.16mmol), the title compound of preparation 65 (320mg, 1.39mmol) and 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (267mg, 1.39mmol) were stirred in dioxane (30ml) at room temperature for 1 hour. The reaction was then heated under reflux for 12 hours, cooled and the solvent evaporated under reduced pressure. The resulting brown oil was dissolved in ethyl acetate (100ml) and washed with water, brine, dried ($MgSO_4$), filtered and the solvent evaporated under reduced pressure. The resulting brown oil was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford the title compound as a foam, 250mg.

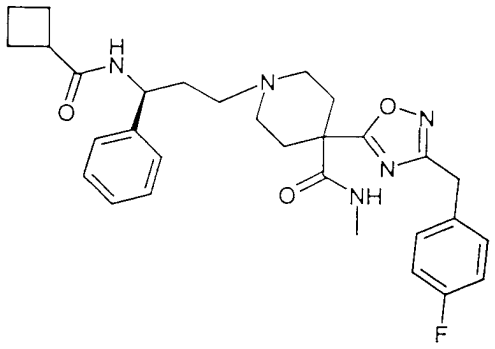
Found C, 61.33; H, 6.56; N, 12.93%
$C_{28}H_{35}N_5SO_4;0.5H_2O$ requires C, 61.52; H, 6.64; N, 12.81%

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.78-2.41 (16H, m), 2.80-3.10 (5H, m), 4.18 (2H, s), 4.89 (2H, bs), 5.09 (1H, dd), 7.18-7.40 (5H, m), 7.42 (1H, m), 7.58 (1H, d), 7.81 (1H, d), 7.91 (1H, s)

LRMS: m/z 538 (MH^+)

EXAMPLE 47

1-{(3*S*)-3-[(Cyclobutylcarbonyl)amino]-3-phenylpropyl}-4-[3-(4-fluorobenzyl)-1,2,4-oxadiazol-5-yl]-*N*-methyl-4-piperidinecarboxamide



Sodium triacetoxyborohydride (159mg, 0.71mmol) was added to a solution of the title compound of preparation 109 (153mg, 0.48mmol) and the title compound of preparation 8 (164mg, 0.71mmol) in dichloromethane:acetic acid (10ml, 10%). The reaction mixture was stirred for 18 hours at room temperature, then partitioned between dichloromethane and saturated aqueous sodium carbonate solution. The organic extract was separated, concentrated and purified by column chromatography on silica gel using dichloromethane:methanol (95:5) as eluant to afford the title compound as a foam, 60mg.

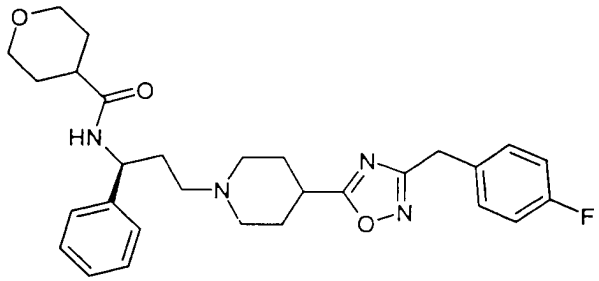
^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.41-2.53 (18H, m), 2.6-2.9 (4H, m), 3.02 (1H, q), 4.04 (2H, s), 5.12 (1H, dd), 5.88 (1H, s), 7.00 (2H, m), 7.26 (7H, m)

LRMS: m/z 534.5 (MH^+)

$[\alpha]_D$ -28 (c = 1, methanol)

EXAMPLE 48

N-((1*S*)-3-{4-[3-(4-Fluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)tetrahydro-2*H*-pyran-4-carboxamide



The title compound of preparation 92 (150mg, 0.38mmol), the title compound of preparation 17 (59mg, 0.45mmol) and 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (87mg, 0.45mmol) were stirred together in dichloromethane (10 ml) at room temperature for 2 hours. The reaction mixture was then washed with brine (2×), dried ($MgSO_4$), filtered and concentrated under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane:methanol (98:2) as eluant to afford the title compound as a white solid, 113mg.

Found C, 67.77; H, 6.99; N, 10.84%

$C_{29}H_{35}N_4O_3F;0.5H_2O$ requires C, 67.55; H, 7.04; N 10.87%

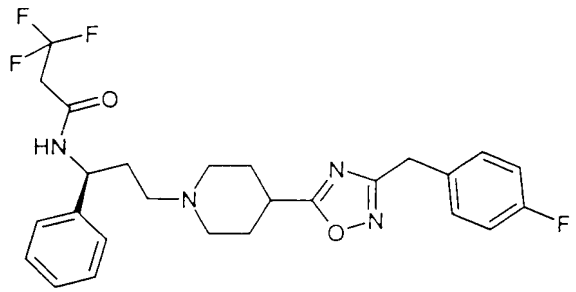
^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.80-2.10 (11H, m), 2.20-2.40 (4H, m), 2.90 (2H, m), 3.05 (1H, m), 3.40 (2H, t), 3.98 (2H, m), 4.00 (2H, s), 5.10 (1H, m), 7.00 (2H, m), 7.18-7.30 (7H, m), 7.90 (1H, d)

LRMS: m/z 507 (MH^+)

$[\alpha]_D$ -30.6 (c = 1.0, MeOH)

EXAMPLE 49

3,3,3-Trifluoro-*N*-((1*S*)-3-{4-[3-(4-fluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)propanamide



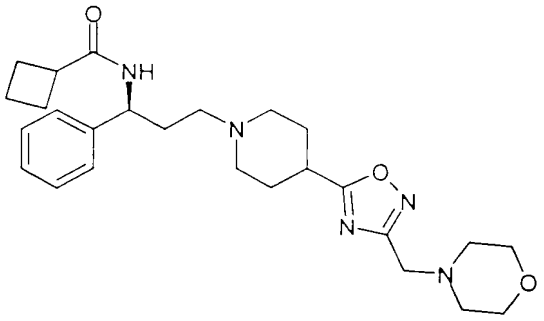
The title compound of preparation 92 (15mg, 0.38mmol), 3,3,3-trifluoropropionic acid (58mg, 0.45mmol) and 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (87mg, 0.45mmol) were stirred together in dichloromethane (10 ml) at room temperature for 2 hours. The reaction mixture was then washed with brine (2×), dried ($MgSO_4$), filtered and concentrated under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane:methanol (95:5) as eluant to afford the title compound as an oil, 100mg.

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.80-2.00 (3H, m), 2.00-2.20 (5H, m), 2.28 (1H, m), 2.40 (1H, m), 2.82-2.99 (2H, m), 3.00 (3H, m), 4.00 (2H, s), 5.18 (1H, dd), 7.00 (2H, m), 7.20-7.35 (7H, m), 8.40 (1H, d).

LRMS: m/z 505 (MH^+)

EXAMPLE 50

N-((1*S*)-3-{4-[3-(4-Morpholinylmethyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)cyclobutanecarboxamide



1-(3-Dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (190mg, 0.91mmol) was added to a solution of triethylamine (0.15ml, 0.93mmol) and the title compound of preparation 115 (300mg, 0.91mmol) in dichloromethane (30ml) and the mixture stirred for 10 minutes. The title compound of preparation 58 (140mg, 0.88mmol) was added and the mixture stirred for 2 hours, then concentrated under reduced pressure. The residue was dissolved in dioxane (30ml) and heated under reflux for 15 hours. The mixture was concentrated under reduced pressure and the residue taken up in saturated aqueous sodium carbonate solution and extracted with ethyl acetate (3x). The combined organic layers were washed with brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (97:3:0.3) as eluant to afford the title compound as a white foam, 40mg.

Found C, 64.92; H, 8.05; N, 14.68%

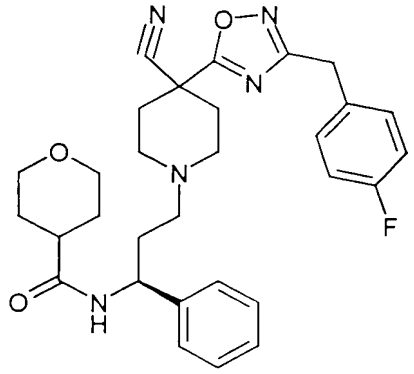
$C_{26}H_{37}N_5O_3$;0.75H_2O, requires C, 64.91; H, 8.07; N, 14.56%

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.81-2.42 (16H, m), 2.60 (4H, m), 2.84-3.08 (4H, m), 3.67 (2H, s), 3.75 (4H, m), 5.12 (2H, m), 7.20-7.25 (2H, m), 7.30-7.37 (3H, m)

LRMS: m/z 469 (MH^+)

EXAMPLE 51

N-((1*S*)-3-{4-Cyano-4-[3-(4-fluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)tetrahydro-2*H*-pyran-4-carboxamide



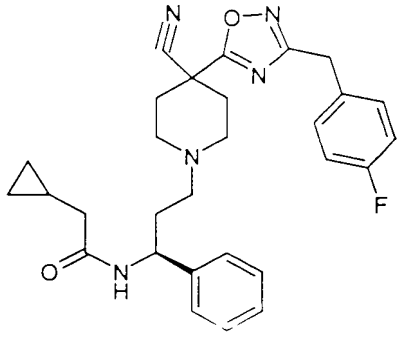
To a stirred solution of the title compound of preparation 111 (68mg, 0.16mmol) in dichloromethane (2ml) was added the title compound of preparation 17 (25mg, 0.19mmol) and 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide (36mg, 0.19mmol). The reaction mixture was stirred for 2 hours at room temperature, then partitioned between dichloromethane and water. The organic extract was separated, concentrated under reduced pressure and the residue purified by column chromatography on silica gel using dichloromethane:methanol (90:10) as eluant to afford the title compound as a white foam, 31mg.

^{1}H NMR (300 MHz, $CDCl_3$ + DMSOd6): δ [ppm] 0.85 (1H, m), 1.54 (4H, m), 1.74 (2H, m), 1.98 (2H, m), 2.33 (6H, m), 2.94 (2H, m), 3.38 (2H, m), 3.97 (2H, m), 4.06 (2H, s), 5.09 (1H, dd), 6.73 (1H, d), 7.03 (2H, m), 7.26 (7H, m)

LRMS: m/z 532.6 (MH^+)

EXAMPLE 52

N-((1*S*)-3-{4-Cyano-4-[3-(4-fluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)-2-cyclopropylacetamide



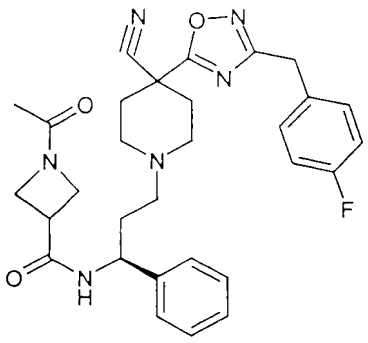
To a stirred solution of the title compound of preparation 111 (68mg, 0.16mmol) in dichloromethane (2ml) was added cyclopropaneacetic acid (19mg, 0.19mmol) and 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide (36mg, 0.19mmol). The reaction mixture was stirred for 2 hours at room temperature, then partitioned between dichloromethane and water. The organic extract was separated, concentrated under reduced pressure and the residue purified by column chromatography on silica gel using dichloromethane:methanol (90:10) as eluant to afford the title compound as a white foam, 35mg.

^{1}H NMR (300 MHz, $CDCl_3$ + DMSOd6): δ [ppm] 0.18 (2H, m), 0.59 (2H, m), 0.90 (1H, m), 2.22 (12H, m), 2.90 (2H, m), 4.04 (2H, s), 5.12 (1H, dd), 6.58 (1H, d), 7.02 (2H, m), 7.26 (7H, m)

LRMS: m/z 502.6 (MH^+)

EXAMPLE 53

1-Acetyl-*N*-((1*S*)-3-{4-cyano-4-[3-(4-fluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)-3-azetidinecarboxamide



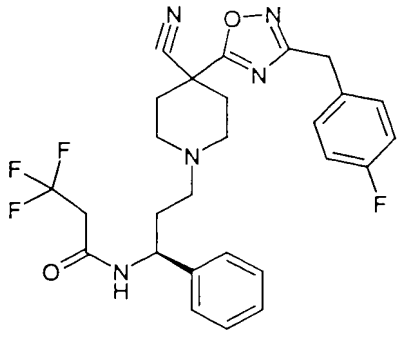
To a stirred solution of the title compound of preparation 111 (68mg, 0.16mmol) in dichloromethane (2ml) was added the title compound of preparation 14 (27mg, 0.19mmol) and 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide (36mg, 0.19mmol). The reaction mixture was stirred for 2 hours at room temperature, then partitioned between dichloromethane and water. The organic extract was separated, concentrated under reduced pressure and the residue purified by column chromatography on silica gel using dichloromethane:methanol (90:10) as eluant to afford the title compound as a white foam, 33mg.

^{1}H NMR (300 MHz, $CDCl_3$ + DMSOd6): δ [ppm] 1.23 (2H, m), 1.83 (2H, m), 2.00 (3H, s), 2.38 (7H, m), 2.90 (2H, m), 3.08 (1H, m), 4.04 (2H, s), 4.12 (2H, m), 4.38 (1H, m), 5.12 (1H, dd), 7.02 (2H, m), 7.23 (7H, m)

LRMS: m/z 545.6 (MH^+)

EXAMPLE 54

N-((1*S*)-3-{4-Cyano-4-[3-(4-fluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)-3,3,3-trifluoropropanamide



To a stirred solution of the title compound of preparation 111 (68mg, 0.16mmol) in dichloromethane (2ml) was added 3,3,3-trifluoropropionic acid (24mg, 0.19mmol) and 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide (36mg, 0.19mmol). The reaction mixture was stirred for 2 hours at room temperature, then partitioned between dichloromethane and water.

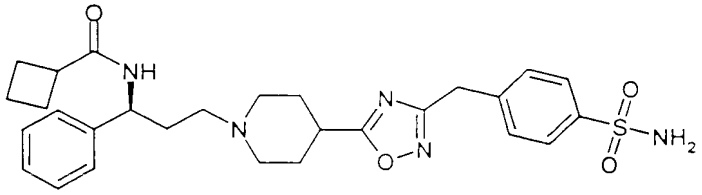
The organic extract was separated, concentrated under reduced pressure and the residue purified by column chromatography on silica gel using dichloromethane:methanol (90:10) as eluant to afford the title compound as a white foam, 39mg.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 2.00 (2H, m), 2.38 (8H, m), 2.94 (2H, m), 3.05 (2H, q), 4.06 (2H, s), 5.18 (1H, dd), 7.02 (2H, m), 7.26 (7H, m)

LRMS: m/z 530.6 (MH^+)

EXAMPLE 55

N-[(1*S*)-3-(4-{3-[4-(Aminosulfonyl)benzyl]-1,2,4-oxadiazol-5-yl}-1-piperidinyl)-1-phenylpropyl]cyclobutanecarboxamide



A solution of the title compound of preparation 64 (175mg, 0.77mmol), the title compound of preparation 115 (290mg, 0.85mmol) and 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (176mg, 0.92mmol) in dioxane (25ml) was stirred for 72 hours at room temperature and then heated under reflux for 5 hours. The mixture was cooled and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95 5:0.5) as eluant to afford the title compound as a white solid, 10mg.

Found C, 61.78; H, 6.74; N, 12.62%

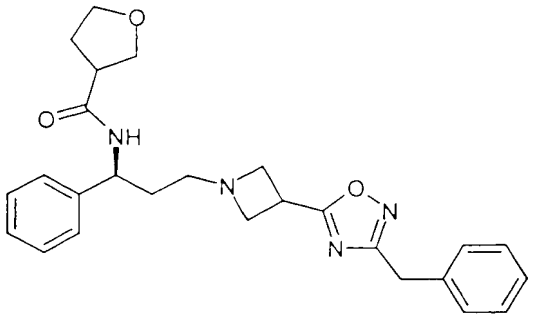
$C_{27}H_{35}N_5SO_4$;0.1CH_2Cl_2 requires C, 61.80; H, 6.50; N, 12.82%

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm]: 1.18-1.22 (1H, m), 1.78-1.98 (5H, m), 2.00-2.19 (7H, m), 2.20-2.40 (4H, m), 2.82-3.09 (4H, m), 3.42-3.51 (1H, m), 4.10 (2H, m), 5.02-5.19 (2H, m), 7.18-7.28 (5H, m), 7.46 (2H, d), 7.86 (2H, d)

LRMS: m/z 538.5 (MH^+)

EXAMPLE 56

N-{(1*S*)-3-[3-Benzyl-1,2,4-oxadiazol-5-yl)-1-azetidinyl]-1-phenylpropyl}tetrahydro-3-furancarboxamide



The title compound of preparation 93 (150mg, 0.43mmol) was added to a solution of tetrahydro-3-furoic acid (50μl, 0.50mmol) and 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (100mg, 0.52mmol) in dichloromethane and stirred for 4 hours. The mixture was basified by the addition of saturated aqueous sodium carbonate solution and extracted with ethyl acetate (3x). The combined organic layers were washed with brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford the title compound as a white foam, 90mg.

Found C, 68.57; H, 6.86; N, 12.33%

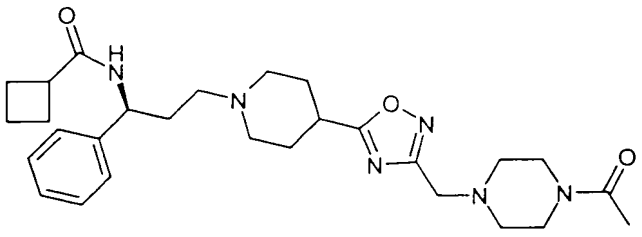
$C_{26}H_{30}N_4O_3;0.5H_2O$ requires C, 68.55; H, 6.86; N 12.30%

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.76 (1H, m), 1.84 (1H, m), 2.13 (2H, m), 2.47 (1H, m), 2.52 (1H, m), 2.95 (1H, m), 3.45 (2H, m), 3.63 (2H, m), 3.82 (2H, m), 3.90 (3H, m), 4.11 (2H, s), 5.12 (1H, dd), 7.2-7.36 (10H, m), 7.70 (1H, m)

LRMS: m/z 447 (MH^+)

EXAMPLE 57

N-[(1*S*)-3-(4-{3-[(4-Acetyl-1-piperazinyl)methyl]-1,2,4-oxadiazol-5-yl}-1-piperidinyl)-1-phenylpropyl]cyclobutanecarboxamide



1-(3-Dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (305mg, 1.61mmol) was added to a solution of triethylamine (0.22ml, 1.63mmol) and the title compound of preparation 115 (500mg, 1.45mmol) in dichloromethane (25ml) and stirred for 10 minutes. The title compound of preparation 69 (350mg, 1.81mmol) was added and the mixture stirred for 2 hours then the mixture was concentrated under reduced pressure. The residue was dissolved in dioxane (25ml) and heated under reflux for 15 hours. The mixture was

concentrated under reduced pressure and the residue taken up in saturated aqueous sodium carbonate solution and extracted with ethyl acetate (3x). The combined organic layers were washed with brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (97:3:0.3) as eluant to afford the title compound as a white foam, 45mg.

Found C, 63.49; H, 8.10; N, 15.90%

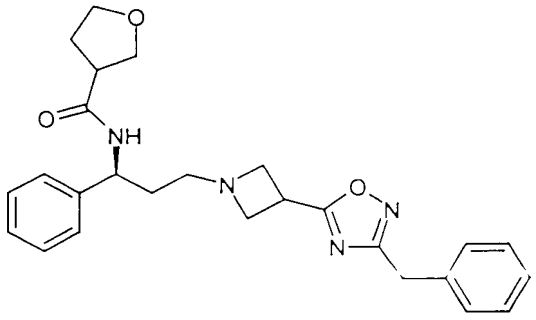
$C_{28}H_{40}N_6O_3;1H_2O$ requires C, 63.85; H, 8.04; N 15.96%

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.8-2.2 (16H, m), 2.2-2.4 (4H, m), 2.54 (4H, m), 2.85-3.05 (4H, m), 3.51 (2H, m), 3.59 (2H, m), 3.62 (1H, s), 5.12 (1H, dd), 7.2-7.35 (2H, m), 7.37 (4H, m)

LRMS: m/z 510 (MH^+)

EXAMPLE 58

N-{(1*S*)-3-[3-Benzyl-1,2,4-oxadiazol-5-yl)-1-azetidinyl]-1-phenylpropyl}tetrahydro-3-furancarboxamide



The title compound of preparation 93 (150mg, 0.43mmol) was added to a solution of tetrahydro-3-furoic acid (50µl, 0.52mmol) and 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (100mg, 0.52mmol) in dichloromethane and stirred for 4 hours. The mixture was basified by the addition of saturated aqueous sodium bicarbonate solution and extracted with ethyl acetate (3x). The combined organic layers were washed with brine, dried, ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford the title compound, 90mg.

Found C, 68.57; H, 6.86; N, 12.33%

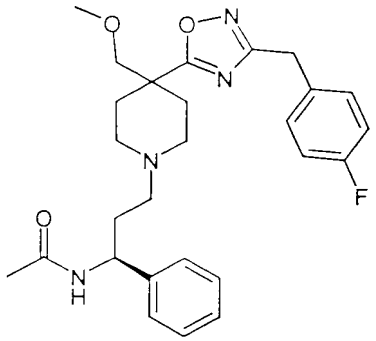
$C_{26}H_{30}N_4O_3;0.5H_2O$ requires C, 68.55; H, 6.86; N 12.30%

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.76 (1H, m), 1.84 (1H, m), 2.13 (2H, m), 2.47 (1H, m), 2.52 (1H, m), 2.95 (1H, m), 3.45 (2H, q), 3.63 (2H, q), 3.82 (2H, m), 3.90 (3H, m), 4.11 (2H, s), 5.12 (1H, q), 7.2-7.36 (10H, m), 7.70 (1H, m)

LRMS: m/z 447 (MH^+)

EXAMPLE 59

N-{(1*S*)-3-[4-[3-(4-Fluorobenzyl)-1,2,4-oxadiazol-5-yl]-4-(methoxymethyl)-1-piperidinyl]-1-phenylpropyl}acetamide



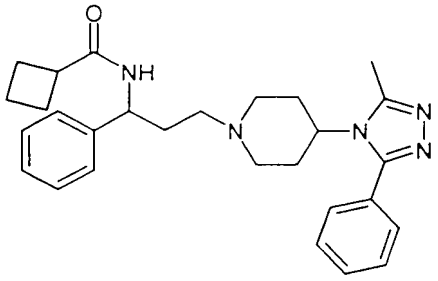
To a stirred solution of the title compound of preparation 151 (88mg, 0.2mmol) was added acetyl chloride (16μl, 0.22mmol) and triethylamine (31μl, 0.22mmol). The reaction mixture was stirred for 2 hours at room temperature, concentrated under reduced pressure and the residue purified by column chromatography on silica gel using dichloromethane:methanol (90:10) as eluant to afford the title compound as a white foam, 45mg.

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.94 (9H, m), 2.31 (4H, m), 2.68 (1H, m), 2.84 (1H, m), 3.22 (3H, s), 3.52 (2H, s), 4.04 (2H, s), 5.09 (1H, q), 6.99 (2H, t), 7.26 (7H, m), 7.64 (1H, m)

LRMS: m/z 481.3 (MH^+)

EXAMPLE 60

N-{3-[4-(3-Methyl-5-phenyl-4*H*-1,2,4-triazol-4-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide



Sodium triacetoxyborohydride (525mg, 2.47mmol) was added to a solution of the title compounds of preparation 120 (400mg, 1.65mmol) and preparation 3 (419mg, 1.82mmol) in dichloromethane/acetic acid (10ml, 10%solution). The reaction mixture was stirred for 30

minutes after which time the solution was basified using saturated aqueous sodium carbonate solution and the product extracted using dichloromethane (3x). The combined organic extracts were dried ($MgSO_4$), filtered and the solvent evaporated under reduced pressure to give a brown oil. This was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (98:2:0.3) as eluant to afford the title compound as a white foam that was freeze dried from water/acetonitrile to afford a white solid, 130mg.

Found C, 71.54; H, 7.77; N, 14.88%

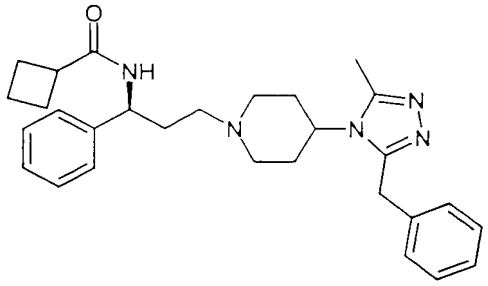
$C_{28}H_{35}N_5O;0.6H_2O$ requires C, 71.80; H, 7.79; N, 14.95%

^1H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.78-2.00 (8H, m), 2.06 (3H, m), 2.18-2.20 (5H, m), 2.61 (3H, s), 2.98 (3H, m), 4.01 (1H, m), 5.09 (1H, dd), 6.58 (1H, d), 7.18-7.30 (5H, m), 7.40-7.48 (5H, m)

LRMS: m/z 458 (MH^+)

EXAMPLE 61

N-{(1*S*)-3-[4-(3-Benzyl-5-methyl-4*H*-1,2,4-triazol-4-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide



The title compound of preparation 121 (500mg, 1.95mmol) and the title compound of preparation 8 (902mg, 3.91mmol) were dissolved in dichloromethane (20ml) and stirred for 5 minutes. Sodium triacetoxyborohydride (620mg, 2.93mmol) was then added and the mixture was stirred for a further 2 hours. The mixture was washed with saturated aqueous sodium bicarbonate solution, water and brine, dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford the title compound as a white foam, 330mg.

Found C, 71.70; H, 8.11; N, 14.35%

$C_{29}H_{37}N_5O;0.8H_2O$ requires C, 71.66; H, 8.00; N, 14.41%

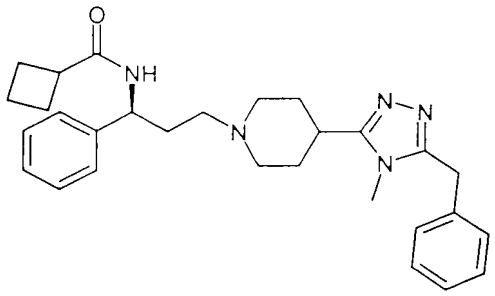
^1H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.29-1.42 (2H, m), 1.60-2.09 (9H, m), 2.10-2.18 (2H, m), 2.20-2.31 (3H, m), 2.53 (3H, s), 2.82-3.01 (3H, m), 3.70-3.82 (1H, m), 4.09 (2H, s), 5.00-5.10 (1H, m), 6.50-6.58 (1H, m), 7.17-7.38 (10H, m)

LRMS: m/z 473 (MH^+)

$[\alpha]_D$ -34.3 (c = 2.00, methanol)

EXAMPLE 62

N-{(1*S*)-3-[4-(5-Benzyl-4-methyl-4*H*-1,2,4-triazol-3-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide



Sodium triacetoxyborohydride (318mg, 1.50mmol) was added to a solution of the title compounds of preparation 146 (256mg, 1.00mmol) and preparation 8 (231mg, 1.00mmol) in dichloromethane:acetic acid (10ml, 10% solution). The reaction mixture was stirred for 30 minutes after which time the solution was basified using saturated aqueous sodium carbonate solution and the product was extracted using dichloromethane (3x). The combined organic extracts were dried ($MgSO_4$), filtered and the solvent evaporated under reduced pressure to give a brown oil. This was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford the title compound as a white foam, 70mg.

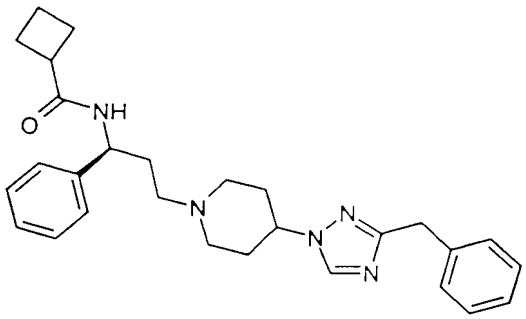
Found C, 71.91; H, 7.78; N, 14.04%
$C_{29}H_{37}N_5O;0.8H_2O$ requires C, 71.66; H, 8.00; N, 14.41%

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.78-2.40 (17H, m), 2.59 (1H, m), 2.89-3.17 (3H, m), 3.30 (3H, s), 4.20 (2H, m), 5.18 (1H, dd), 7.16-7.40 (9H, m), 7.63 (1H, d)

LRMS: m/z 472 (MH^+)

EXAMPLE 63

N-{(1*S*)-3-[4-(3-Benzyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}-cyclobutanecarboxamide



Sodium triacetoxyborohydride (190mg, 0.92mmol) was added to a solution of the title compound of preparation 134 (220mg, 0.61mmol) and the title compound of preparation 8 (200mg, 0.82mmol) in dichloromethane:acetic acid (20ml, 10% solution) and stirred at room temperature for 15 hours. The mixture was basified by the addition of saturated aqueous sodium carbonate solution and extracted with dichloromethane (3x). The combined organic extracts were washed with brine and dried ($MgSO_4$), filtered and solvent evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (97:3:0.3) as eluant. This gave a brown oil which was further purified by column chromatography on silica gel using toluene:ethyl acetate:diethylamine (90:10:1) as eluant to afford the title compound as a white solid, 106mg.

Found C, 72.01; H, 7.81; N, 14.72%

$C_{28}H_{35}N_5O;0.5H_2O$ requires C, 72.07; H, 7.78; N 15.01%

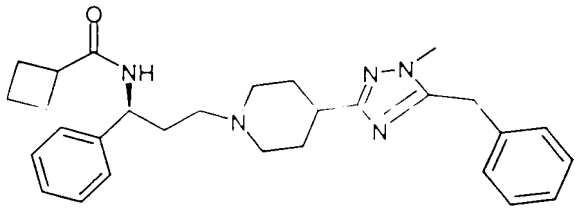
^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.80-2.40 (17H, m), 3.00 (3H, m), 4.05 (2H, s), 4.10 (1H, m), 5.15 (1H, dd), 7.25-7.35 (10H, m), 8.00 (1H, s)

LRMS: m/z 458 (MH^+)

$[a]_D$ -39.6 (c = 0.1, methanol)

EXAMPLE 64

N-{(1*S*)-3-[4-(5-Benzyl-1-methyl-1*H*-1,2,4-triazol-3-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide



Sodium triacetoxyborohydride (290mg, 1.40mmol) was added to a solution of the title compound of preparation 8 (310mg, 1.34mmol) and the title compound of preparation 130 (230mg, 0.93mmol) in dichloromethane:acetic acid (10ml, 10% solution) and stirred at room temperature for 15 hours. The reaction mixture was basified by the addition of saturated aqueous sodium bicarbonate solution and extracted with dichloromethane (3x). The combined organic layers were washed with brine, dried ($MgSO_4$), filtered and concentrated under reduced pressure. The residue was purified by column chromatography on silica gel using toluene:ethyl acetate: diethylamine (80:20:1) as eluant to afford the title compound, 210mg.

Found C, 70.94; H, 8.05; N, 14.28%

$C_{29}H_{37}N_5O;H_2O$ requires C, 71.13; H, 8.03; N 14.30%

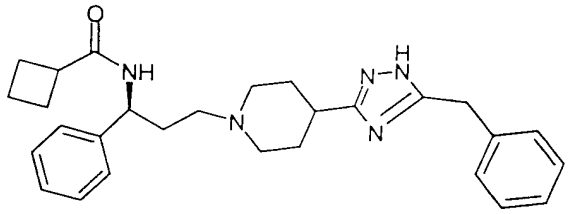
^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.71-2.42 (16H, m), 2.70 (1H, m), 2.80 (1H, d), 3.10 (2H, m), 3.61 (3H, s), 4.16 (2H, s), 5.10 (1H, m), 7.15-7.35 (10H, m), 8.05 (1H, bs)

LRMS: m/z 473 (MH^+)

$[a]_D$ -42 (c = 0.1, methanol)

EXAMPLE 65

N-{3-[4-(5-Benzyl-1*H*-1,2,4-triazol-3-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide



Sodium triacetoxyborohydride (490mg, 2.32mmol) was added to a solution of the title compound of preparation 129 (1.09g, 1.55mmol) and the title compound of preparation 8 (717mg, 3.01mmol) in dichloromethane (20ml) and stirred at room temperature for 15 hours. The mixture was basified by the addition of saturated aqueous sodium bicarbonate solution and extracted with dichloromethane (3x). The combined organic layers were dried ($MgSO_4$), filtered and the solvent evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (190:10:1) giving impure material which was further purified by preparative HPLC (phenomonex magellenC_{18} (2) aqueous TFA 0.1%:acetonitrile 1:19-19:1) and freeze dried from acetonitrile:water to afford the title compound as a white foam, 75mg.

Found: C, 53.65; H, 5.48; N, 9.51%

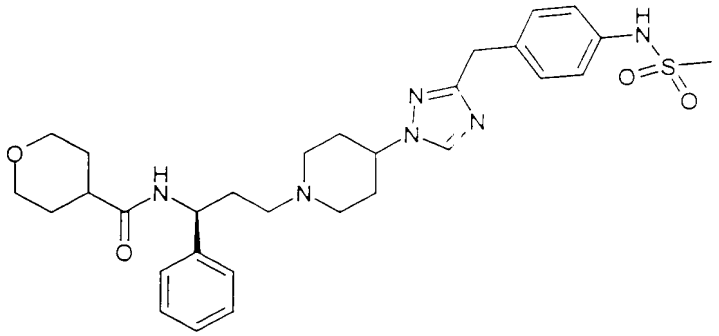
$C_{28}H_{35}N_5O;2CF_3CO_2H;1.5H_2O$ requires C, 53.93; H, 5.66; N 9.83%

^1H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.77-2.00 (2H, m), 2.12-2.41 (9H, m), 2.85-2.95 (2H, m), 3.0-3.2 (4H, m), 3.40 (2H, m), 3.60 (2H, d), 4.20 (2H, m), 5.00 (1H, m), 6.40 (1H, d), 7.23-7.44 (10H, m)

LRMS: m/z 459 (MH^+)

EXAMPLE 66

N-{(1*S*)-3-[4-(3-{4-[(methylsulfonyl)amino]benzyl}-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}tetrahydro-2*H*-pyran-4-carboxamide



The title compound of preparation 138 (135mg, 0 24mmol) was stirred for 1hour at 37°C in a mixture of trifluoroacetic acid:dichloromethane (4ml, 10:1). The solvents were evaporated under reduced pressure and the residue basified with saturated aqueous sodium bicarbonate solution and extracted with dichloromethane (6x). The combined organic layers were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue (90mg, 0.19mmol), the title compound of preparation 17 (25mg, 0.19mmol), 1-hydroxybenzotriazole hydrate (29mg, 0.21mmol) and 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (44mg, 0.23mmol) were stirred together for 3 hours at room temperature in dichloromethane (5ml). The reaction mixture was diluted with dichloromethane and washed with saturated aqueous sodium carbonate solution, then water. The organic layer was dried ($MgSO_4$), filtered and evaporated under reduced pressure. Trituration with diethyl ether yielded a solid which was recrystallized from ethanol/isopropyl alcohol to afford the title compound as a crystalline solid, 60mg.

Found C, 61.30; H, 6.89; N, 14.27%

$C_{30}H_{40}N_6O_4S;0.4H_2O$ requires C, 61.29; H, 6.99; N, 14.29%

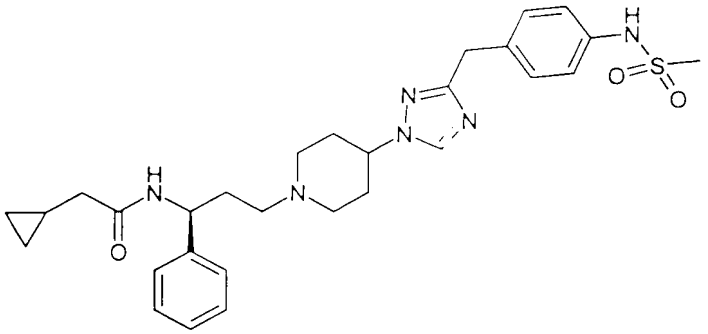
^{1}H NMR (400 MHz, CD_3OD): δ [ppm] 1.60-1.84 (4H, m), 1.90-2.03 (2H, m), 2.03-2.26 (6H, m), 2.32-2.44 (2H, m), 2.44-2.55 (1H, m), 2.89 (3H, s), 2.98-3.08 (2H, m), 3.39-3.50 (2H, m), 3.90-4.00 (2H, m), 4.08 (2H, s), 4.19-4.29 (1H, m), 4.94-5.00 (1H, m), 7.13-7.18 (2H, d), 7.19-7.26 (3H, d), 7.26-7.35 (4H, m), 8.37 (1H, s)

LRMS: m/z 581.2 (MH^+)

Melting point [°C]: 210-211

EXAMPLE 67

2-Cyclopropyl-*N*-{(1*S*)-3-[4-(3-{4-[(methylsulfonyl)amino]benzyl}-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}acetamide



The title compound was prepared using a procedure similar to that described in example 66 from the title compound of preparation 138 and 2-cyclopropylacetic acid in a 35% yield and was recrystallised from isopropyl alcohol/ethyl acetate.

Found C, 62.45; H, 6.95; N, 15.02%

$C_{29}H_{38}N_6O_3S$;0.4 H_2O requires C, 62.43; H, 7.0; N, 15.06%

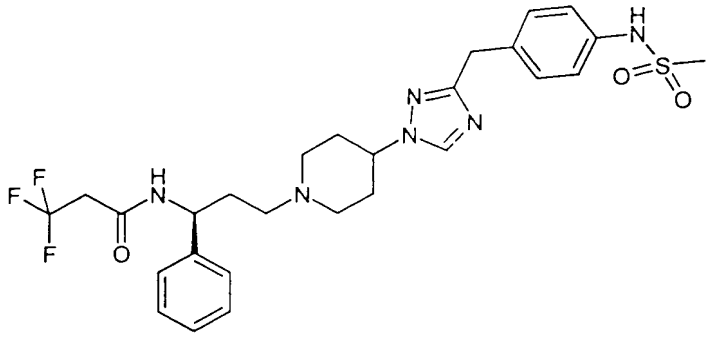
^{1}H NMR (400 MHz, CD_3OD): δ [ppm] 0.16-0.20 (2H, m), 0.48-0.52 (2H, m), 1.00-1.08 (1H, m), 1.94-2.03 (2H, m), 2.03-2.26 (8H, m), 2.32-2.47 (2H, m), 2.90 (3H, s), 3.00-3.08 (2H, m), 4.00 (2H, s), 4.18-4.27 (1H, m), 4.94-5.00 (1H, m), 7.13-7.20 (2H, d), 7.20-7.26 (3H, m), 7.26-7.35 (4H, m), 8.35 (1H, d)

LRMS: m/z 551.2 (MH^+)

Melting point [°C]: 185-186

EXAMPLE 68

3,3,3-Trifluoro-*N*-{(1*S*)-3-[4-(3-{4-[(methylsulfonyl)amino]benzyl}-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}propanamide



The title compound was prepared using a procedure similar to that described in example 66 from the title compound of preparation 138 and 3,3,3-trifluoropropionic acid in a 35% yield and was recrystallised from ethyl acetate.

Found C, 55.88; H, 5.95; N, 14.67%

$C_{27}H_{33}F_3N_6O_3S$ requires C, 56.04; H, 5.75; N, 14.52%

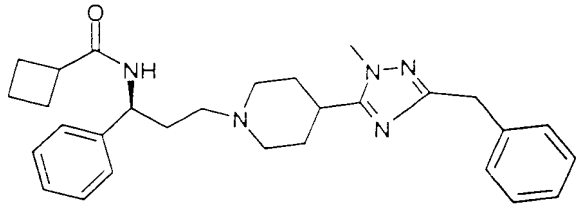
^{1}H NMR (400 MHz, CD_3OD): δ [ppm] 1.95-2.03 (2H, m), 2.03-2.21 (6H, m), 2.34-2.44 (3H, m), 2.90 (3H, s), 2.97-3.05 (2H, m), 3.10-3.24 (2H, m), 3.29 (1H, s), 4.00 (2H, s), 4.20-4.27 (1H, m), 4.95-5.02 (1H, m), 7.13-7.16 (2H, d), 7.20-7.26 (3H, m), 7.32-7.35 (4H, m), 8.37 (1H, s)

LRMS: m/z 579.1 (MH^+)

Melting point [°C]: 162-163

EXAMPLE 69

N-(1*S*)-{3-[4-(3-Benzyl-1-methyl-1*H*-1,2,4-triazol-5-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide



Methyl iodide (0.41ml, 6.42mmol) was added to a suspension of the title compound of preparation 127 (1.00g, 2.90mmol) and potassium carbonate (480mg, 3.51mmol) in acetonitrile (20ml) and the mixture stirred at room temperature for 15 hours. The mixture was concentrated under reduced pressure and the residue taken up in water (100ml) and extracted with dichloromethane (x3). The combined organic layers were washed with brine, dried ($MgSO_4$), filtered and concentrated under reduced pressure. The residue was purified by column chromatography on silica gel, using dichloromethane:methanol (98:2) as eluant to afford a whits solid. Trifluoroacetic acid (2ml) was added to a solution of the white solid in dichloromethane (10ml) at 0°C and the mixture was allowed to warm to room temperature for 15 hours. The mixture was evaporated under reduced pressure and the residue taken up in saturated aqueous sodium carbonate solution and extracted with dichloromethane (x3). The combined organic layers were washed with brine, dried ($MgSO_4$), filtered and the filtrate evaporated under reduced pressure to afford a pale yellow oil. Sodium triacetoxyborohydride (420mg, 2mmol) was added to a solution of piperidine, acetic acid (0.10ml, 5.70mmol) and the title compound of preparation 8 (310mg, 1.32mmol) in dichloromethane (15ml) and stirred at room temperature for 15 hours. The mixture was treated with 2M hydrochloric acid (1ml). The mixture was basified by the addition of saturated aqueous sodium bicarbonate solution and extracted with dichloromethane (3x). The combined organic layers were dried (MgSO4), filtered and solvent evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane: methanol:0.88 ammonia (92:8:1) as eluant giving crude material which was further purified by HPCL (phenomonex Lunac C_8 and

phenomonex Magellen C_{18} (2) using an eluant of ammonium acetate solution and acetonitrile) and freeze-dried from water/acetonitrile to afford the title compound as a white foam, 40mg.

Found C, 71.11; H, 7.99; N, 14.18%.

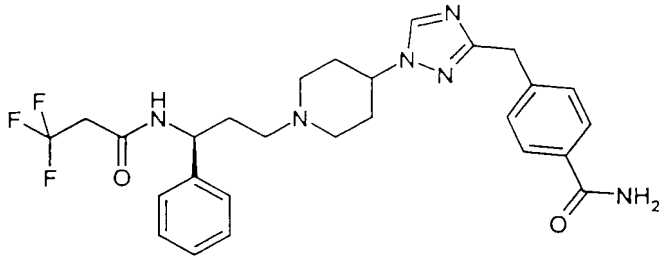
$C_{29}H_{37}N_5O;1H_2O$ requires C, 71.13; H, 8.03; N 14.30%

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.74-1.42 (16H, m), 2.63-2.72 (1H, m), 2.90-2.98 (1H, m), 3.00-3.16 (2H, m), 3.75 (3H, s), 4.02 (2H, s), 5.12 (1H, m), 7.15-7.37 (10H, m), 7.72 (1H, d)

LRMS: m/z 473 (MH^+)

EXAMPLE 70

4-{[1-(1-{(3*S*)-3-Phenyl-3-[(3,3,3-trifluoropropanoyl)amino]propyl}-4-piperidinyl)-1*H*-1,2,4-triazol-3-yl]methyl}benzamide



The title compound of preparation 136 (700mg, 1.35mmol), cyanuric chloride (125mg, 0.67mmol) and triethylamine (0.23ml, 1.35mmol) were stirred together at room temperature for 1 hour in acetone (30ml). The solvent was evaporated under reduced pressure and the residue dissolved in tetrahydrofuran (10ml) and 0.88 ammonia (10ml) added. The solvents were evaporated under reduced pressure and the residue purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford a solid, 280mg. The solid (280mg, 0.54mmol) was stirred for 2 hours at room temperature in a 10ml mixture of trifluoroacetic acid:dichloromethane (1:1). The solvents were evaporated under reduced pressure and the residue basified with saturated aqueous sodium carbonate solution and extracted with dichloromethane (x6).The combined organic layers were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue (70mg, 0.17mmol), 3,3,3-trifluoropropanoic acid (21mg, 0.17mmol), 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (35mg, 0.18mmol) and triethylamine (28μl, 0.20mmol) were stirred together for 16 hours at room temperature in dichloromethane (5ml). The solvent was evaporated under reduced pressureand the residue dissolved in ethyl acetate and washed with saturated aqueous sodium carbonate solution, then water. The organic layer was dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was recrystallized from ethyl acetate/hexane to afford the title compound as a crystalline solid, 21mg.

Found C, 60.14; H, 6.07; N, 15.44%

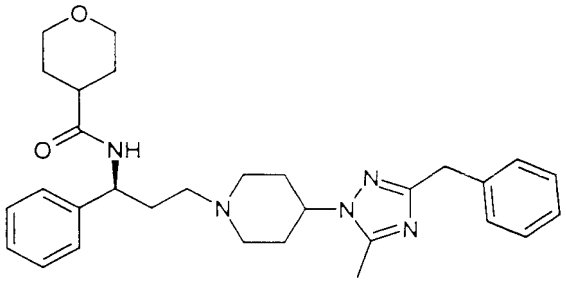
$C_{27}H_{29}F_3N_6O_2$;0.6H_2O requires C, 60.12; H, 6.02; N, 15.58%

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.82-1.92 (1H, m), 1.92-2.26 (7H, m), 2.26-2.37 (1H, m), 2.37-2.47 (1H, m), 2.92-3.01 (1H, m), 3.01-3.16 (3H, m), 4.10 (3H, s), 5.13-5.21 (1H, m), 5.40-5.70 (1H, bs), 5.90-6.20 (1H, bs), 7.20-7.29 (3H, m), 7.29-7.37 (2H, m), 7.37-7.45 (2H, d), 7.71-7.79 (2H, d), 7.97 (1H, s), 8.03-8.10 (1H, m)

LRMS m/z 529.3 (MH^+)

EXAMPLE 71

N-{(1*S*)-3-[4-(3-Benzyl-5-methyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}tetrahydro-2*H*-pyran-4-carboxamide



1-(3-Dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (59mg, 0.31mmol) was added to a stirred solution of the title compound of preparation 17 (40mg, 0.31mmol) and the title compound of preparation 142 (100mg, 0.25mmol) in dichloromethane (10ml). After 1 hour the reaction mixture was loaded directly onto a column of silica and eluted with dichloromethane:methanol:0.88 ammonia (95:5:0.5) to afford the title compound as a white foam, 98mg.

Found C, 69.01; H, 7.63; N, 13.27%

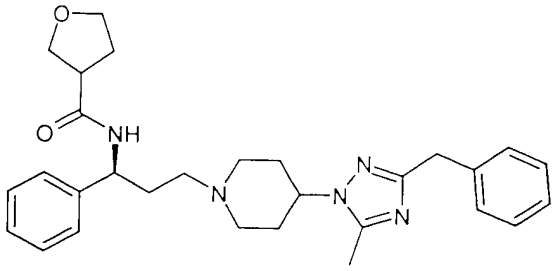
$C_{30}H_{39}N_5O_2$;1.1H_2O requires C, 69.10; H, 7.96; N, 13.43%

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.76-2.08 (13H, m), 2.10-2.51 (6H, m), 2.99 (1H, d), 3.20 (1H, d), 3.49 (2H, m), 3.82-4.17 (5H, m), 5.18 (1H, dd), 7.12-7.36 (9H, m), 8.20 (1H, d)

LRMS. m/z 503 (MH^+)

EXAMPLE 72

N-{(1*S*)-3-[4-(3-Benzyl-5-methyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}tetrahydro-3-furancarboxamide

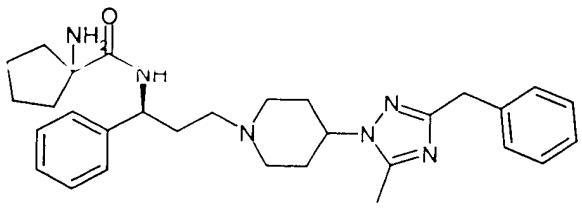


1-(3-Dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (59mg, 0.31mmol) was added to a stirred solution of tetrahydro-3-furoic acid (36mg, 0.31mmol) and the title compound of preparation 142 (100mg, 0.25mmol) in dichloromethane (10ml). After 1 hour the reaction mixture was loaded directly onto a column of silica and eluted with dichloromethane:methanol:0.88 ammonia (95:5:0.5) to afford the title compound as a white foam, 107mg.

Found C, 67.51; H, 7.44; N, 13.40%
$C_{29}H_{37}N_5O_2;1H_2O;0.15CH_2Cl_2$ requires C, 67.54; H, 7.64; N, 13.51%
^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.80-1.99 (3H, m), 2.00-2.41 (14H, m), 3.00 (2H, m), 3.18 (1H, m), 3.80 (1H, m), 3.98 (5H, m), 5.17 (1H, m), 7.18-7.35 (9H, m), 8.82 (1H, d)
LRMS: m/z 488 (MH^+)

EXAMPLE 73

1-Amino-*N*-{(1*S*)-3-[4-(3-benzyl-5-methyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}cyclopentanecarboxamide

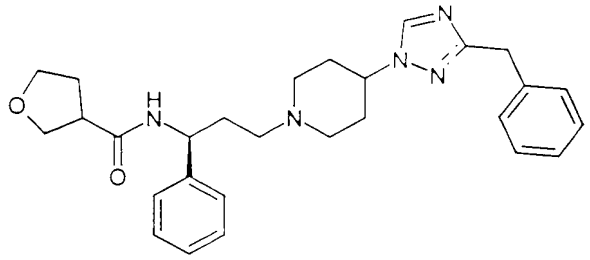


1-(3-Dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (118mg, 0.62mmol) was added to a stirred solution of the title compound of preparation 15 (141mg, 0.62mmol) and the title compound of preparation 142 (200mg, 0.50mmol) in dichloromethane (20ml). After 1 hour trifluoroacetic acid (5ml) was added and the reaction stirred for 12 hours. The solvent was evaporated under reduced pressure and the resulting oil was loaded directly onto a column of silica and eluted with dichloromethane:methanol:0.88 ammonia (95:5:0.5) to afford the title compound as a white foam, 170mg.

Found C, 70.24; H, 8.05; N, 16.35%
$C_{30}H_{40}N_6O;0.6H_2O$ requires C, 70.45; H, 8.12; N, 16.43%
^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.40 (4H, m), 1.62-2.09 (10H, m), 2.15-2.41 (9H, m), 2.98 (1H, d), 3.10 (1H, d), 3.98 (3H, m), 5.10 (1H, dd), 7.06-7.38 (10H, m), 8.95 (1H, d)
LRMS: m/z 501 (MH^+)

EXAMPLE 74

N-{(1*S*)-3-[4-(3-Benzyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}tetrahydro-3-furancarboxamide



The title compound of preparation 134 (1.17g, 4.83mmol), the title compound of preparation 7 (1.20g, 4.83mmol) and sodium triacetoxyborohydride (1.53g, 7.24mmol) were stirred together for 30 minutes at room temperature in dichloromethane:acetic acid (30ml, 10%). The solvents were evaporated under reduced pressure and the residue basified with saturated aqueous sodium carbonate solution and extracted with dichloromethane (3x). The combined organic layers were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue (2.3g, 4.83mmol) was stirred for 16 hours in a mixture of dichloromethane:trifluoroacetic acid (30ml, 5:1). The solvents were evaporated under reduced pressure and the residue basified with saturated aqueous sodium carbonate solution solution and extracted with dichloromethane (3x). The combined organic layers were dried ($MgSO_4$), filtered and evaporated under reduced pressure. A portion of the residue (200mg, 0.53mmol), tetrahydro-3-furancarboxylic acid (65mg, 0.53mmol) and 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (125mg, 0.65mmol) were stirred together for 1 hour at room temperature in dichloromethane (5ml). The solvent was evaporated under reduced pressure. The residue was dissolved in ethyl acetate and washed with saturated aqueous sodium carbonate solution, then water. The organic layer was dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford the title compound as a gum, 183mg.

Found C, 69.42; H, 7.53; N, 14.46%

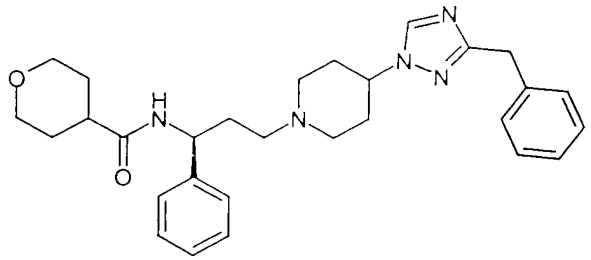
$C_{28}H_{35}N_5O_2$;0.6H_2O requires C, 69.36; H, 7.55; N, 14.49%

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.84-1.94 (1H, m), 2.00-2.23 (9H, m), 2.23-2.32 (1H, m), 2.32-2.44 (1H, m), 2.89-3.02 (2H, m), 3.02-3.11 (1H, m), 3.74-3.82 (1H, m), 3.90-3.97 (3H, m), 4.06 (2H, s), 4.06-4.16 (1H, m), 5.08-5.16 (1H, m), 7.16-7.37 (10H, m), 7.37-7.48 (1H, m), 7.97-8.00 (1H, m)

LRMS: m/z 475 (MH^+)

EXAMPLE 75

N-{(1*S*)-3-[4-(3-Benzyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}tetrahydro-2*H*-pyran-4-carboxamide



The title compound was obtained using a method similar to that described for example 74 from title compounds of preparations 134, 7 and 17 in 67% yield.

Found C, 69.72; H, 7.67; N, 14.11%

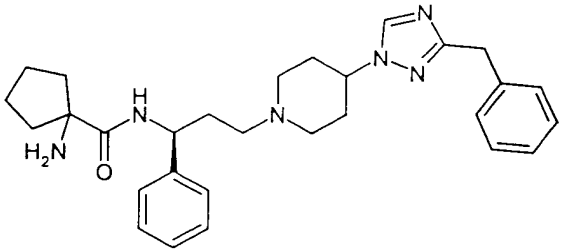
$C_{29}H_{37}N_5O_2$;0.6H_2O requires C, 69.88; H, 7.72; N, 14.05%

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.78-1.92 (5H, m), 2.00-2.21 (7H, m), 2.24-2.32 (1H, m), 2.32-2.45 (2H, m), 2.95-3.06 (1H, m), 3.06-3.16 (1H, m), 3.39-3.48 (2H, m), 4.00-4.06 (4H, m), 4.06-4.19 (1H, m), 5.10-5.18 (1H, m), 7.16-7.35 (10H, m), 7.55-7.61 (1H, m), 8.00 (1H, s).

LRMS: m/z 388.4 (MH^+)

EXAMPLE 76

1-Amino-*N*-{(1*S*)-3-[4-(3-benzyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}cyclopentanecarboxamide



The title compound of preparation 134 (1.17g, 4.83mmol), the title compound of preparation 7 (1.20g, 4.83mmol) and sodium triacetoxyborohydride (1.53g, 7.24mmol) were stirred together for 30 minutes at room temperature in dichloromethane:acetic acid (30ml, 10%). The solvents were evaporated under reduced pressure and the residue basified with saturated aqueous sodium carbonate solution and extracted with dichloromethane (3x). The combined organic layers were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue (2.3g, 4.83mmol) was stirred for 16 hours in a mixture of dichloromethane:trifluoroacetic acid (30ml, 5:1). The solvents were evaporated under reduced pressure and the residue basified with saturated aqueous sodium carbonate solution and

extracted with dichloromethane (3x). The combined organic layers were dried ($MgSO_4$), filtered and evaporated under reduced pressure. A portion of the residue (200mg, 0.53mmol), the title compound of preparation 15 (121mg, 0.53mmol) and 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (125mg, 0.65mmol) were stirred together for 1 hour at room temperature in dichloromethane (5ml) and then trifluoroacetic acid (5ml) was added and the reaction stirred for 12 hours. The solvent was evaporated under reduced pressure. The residue was dissolved in ethyl acetate and washed with saturated aqueous sodium carbonate solution, then water. The organic layer was dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford the title compound as a gum, 58mg.

Found C, 69.89; H, 7.96; N, 16.94%

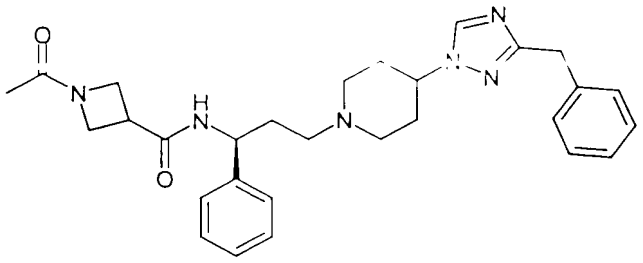
$C_{29}H_{38}N_6O;0.6H_2O$ requires C, 70.02; H, 7.94; N, 16.89%

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.27-1.53 (4H, m), 1.68-1.90 (4H, m), 1.90-2.40 (12H, m), 2.94-3.06 (2H, m), 4.03-4.15 (1H, m), 4.05 (2H, s), 5.03-5.11 (1H, m), 7.16-7.35 (10H, m), 7.97 (1H, s), 8.61-8.69 (1H, m)

LRMS: m/z 488 (MH^+)

EXAMPLE 77

1-Acetyl-*N*-{(1*S*)-3-[4-(3-benzyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}-3-azetidinecarboxamide



The title compound was obtained using a method similar to that described for example 74 from title compounds of preparations 134, 7 and 14 in 48% yield.

Found C, 67.53; H, 7.51; N, 16.66%

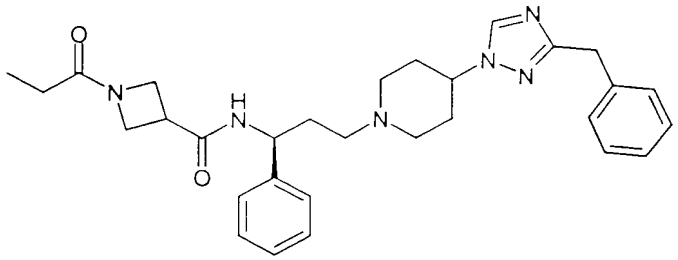
$C_{29}H_{36}N_6O_2;0.7H_2O$ requires C, 67.86; H, 7.34; N, 16.37%

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.80-2.26 (8H, m), 1.84 (3H, s), 2.26-2.35 (1H, m), 2.35-2.45 (1H, m), 2.94-3.11 (2H, m), 3.18-3.29 (1H, m), 4.03-4.26 (4H, m), 4.06 (2H, s), 4.32-4.44 (1H, m), 5.10-5.27 (1H, m), 7.16-7.35 (10H, m), 7.60-7.65 and 7.77-7.83 (1H, m), 8.00 (1H, s)

LRMS: m/z 501.6 (MH^+)

EXAMPLE 78

N-{(1*S*)-3-[4-(3-Benzyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}-1-propionyl-3-azetidinecarboxamide



The title compound of preparation 134 (1.17g, 4.83mmol), the title compound of preparation 7 (1.20g, 4.83mmol) and sodium triacetoxyborohydride (1.53g, 7.24mmol) were stirred together for 30 minutes at room temperature in dichloromethane:acetic acid (30ml, 10%). The solvents were evaporated under reduced pressure and the residue basified with saturated aqueous sodium carbonate solution and extracted with dichloromethane (3x). The combined organic layers were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue (2.3g, 4.83mmol) was stirred for 16 hours in a mixture of dichloromethane:trifluoroacetic acid (30ml, 5:1). The solvents were evaporated under reduced pressure and the residue basified with saturated aqueous sodium carbonate solution and extracted with dichloromethane (3x). The combined organic layers were dried ($MgSO_4$), filtered and evaporated under reduced pressure. A portion of the residue (200mg, 0.53mmol), the title compound of preparation 13 (106mg, 0.53mmol) and 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (125mg, 0.65mmol) were stirred together for 1 hour at room temperature in dichloromethane (5ml) and then trifluoroacetic acid (5ml) was added and the reaction stirred for 12 hours. The solvent was evaporated under reduced pressure. The residue was dissolved in ethyl acetate and washed with saturated aqueous sodium carbonate solution, then water. The organic layer was dried ($MgSO_4$), filtered and evaporated under reduced pressure to furnish an oil. To a solution of this oil (100mg, 0.22mmol) and triethylamine (36µl, 0.26mmol) was added propionyl chloride (20µl, 0.24mmol) with stirring at room temperature. The solvent was evaporated under reduced pressure. The residue was dissolved in ethyl acetate and washed with saturated aqueous sodium carbonate solution, then water. The organics were dried ($MgSO_4$), filtered and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using dichloromethane:methanol:0.88 ammonia (98:2:0.25) as eluant to afford the title compound as a gum, 41mg.

Found C, 66.89; H, 7.66; N, 15.75%

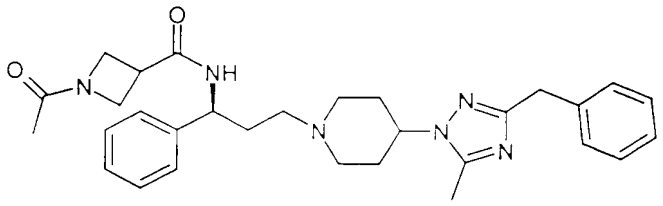
$C_{30}H_{38}N_6O_2;1H_2O;0.06CH_2Cl_2$ requires C, 67.14; H, 7.52; N, 15.63%

^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] 1.06-1.13 (3H, t), 1.74-2.47 (12H, m), 2.94-3.13 (2H, m), 3.19-3.32 (1H, m), 4.03-4.26 (4H, m), 4.05 (2H, s), 4.32-4.42 (1H, m), 5.11-5.16 (1H, m), 7.18-7.37 (10H, m), 7.55-7.60 and 7.74-7.80 (1H, m), 8.02 (1H, s)

LRMS: m/z 515.3 (MH^+)

EXAMPLE 79

1-Acetyl-*N*-{(1*S*)-3-[4-(3-benzyl-5-methyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}-3-azetidinecarboxamide



1-(3-Dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (96mg, 0.50mmol) was added to a stirred solution acetic acid (28μl, 0.50mmol) and the title compound of preparation 143 (200mg, 0.42mmol) in dichloromethane (10ml). After 1 hour the reaction mixture was loaded directly onto a column of silica with dichloromethane:methanol:0.88 ammonia (95:5:0.5) as eluant to afford the title compound as a white foam, 102mg.

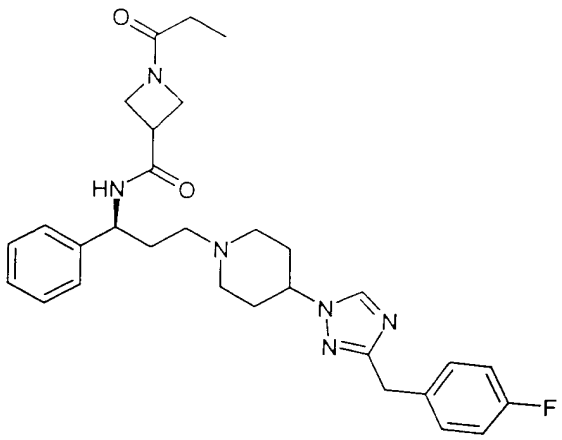
Found C, 67.74; H, 7.44; N, 16.03%
$C_{30}H_{38}N_6O_2$;$1H_2O$ requires C, 67.64; H, 7.57; N, 15.78%

^{1}H NMR (300 MHz, $CDCl_3$): δ [ppm] 1.76-2.50 (18H, m), 3.00 (1H, m), 3.18 (1H, dd), 3.30 (1H, ddd), 3.98 (3H, m), 4.18 (2H, m), 4.38 (1H, m), 5.16 (1H, dd), 7.08-7.40 (9H, m), 8.26 (0.5H, d), 8.44 (0.5H, dd)

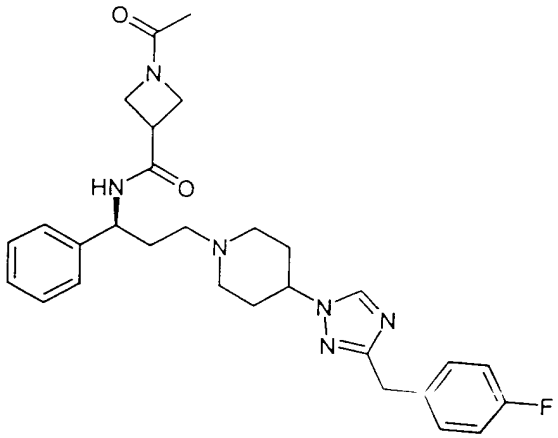
LRMS: m/z 515 (MH^+)

The following compounds have been prepared using methods similar to those described above:

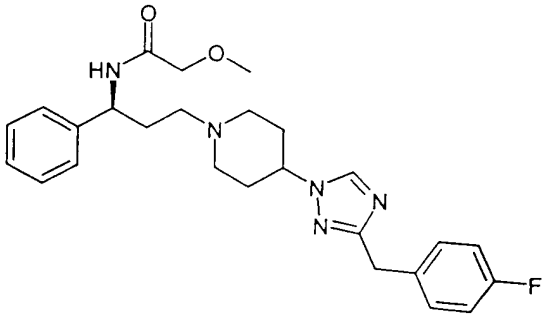
N-{(1*S*)-3-[4-(3-(4-Fluorobenzyl)-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}-1-propionyl-3-azetidinecarboxamide



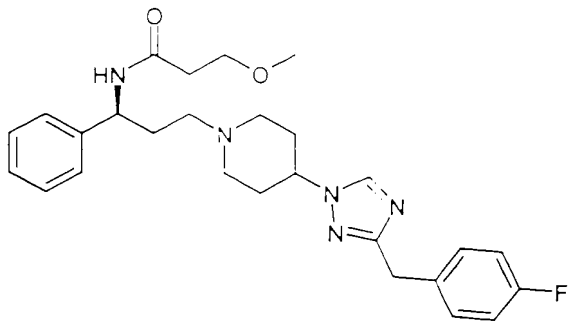
1-Acetyl-*N*-{(1*S*)-3-[4-(3-(4-fluorobenzyl)-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}-3-azetidinecarboxamide



2-Methoxy-*N*-{(1*S*)-3-[4-(3-(4-fluorobenzyl)-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}acetamide



3-Methoxy-*N*-{(1*S*)-3-[4-(3-(4-fluorobenzyl)-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}propanamide


O
HN
O
N
N
N
N
F

CLAIMS

1. A compound of Formula (I);

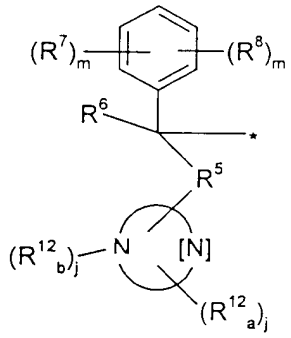
$[R_{egion\ \alpha}]$ - $[R_{egion\ \beta}]$ - $[R_{egion\ \gamma}]$ - $[R_{egion\ \delta}]$ (I)

wherein:

$[R_{egion\ \alpha}]$ is selected from the group consisting of:

-A. Aryl heterocyclyl substituent components comprising:

--1. hetero-phenylmethylene moieties of partial Formula (1.0.0):



(1.0.0)

wherein: the symbol " * " indicates the point of attachment of the moiety of partial Formula (1.0.0) to $R_{egion\ \beta}$, as hereinafter defined;

---R^5 is a member selected from the group consisting of a direct bond; -O-; -C(=O)-; -NR^4-; and -$S(=O)_p$-; where:

----R^4 is hydrogen or (C_1 -C_2)alkyl;

---R^6 is a member selected from the group consisting of hydrogen; (C_1 -C_2)alkyl; (C_1 -C_2)alkoxy; -CN; -OH; and -C(=O)NH_2;

---j is an integer selected from 0, 1, and 2;

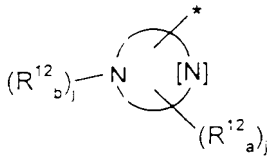
---m is an integer selected from 0, 1, and 2;

---R^7 and R^8 are each a member selected from the group consisting of -F; -Cl; -CO_2R^4; -OH; -CN; -$CONR^4_aR^4_b$; -$NR^4_aR^4_b$-; -$NR^4_aC(=O)R^4_b$; -$NR^4_aC(=O)OR^4_b$; -$NR^4_aS(=O)_pR^4_b$; -$S(=O)_pNR^4_aR^4_b$; (C_1 -C_4)alkyl, and (C_1 -C_4)alkoxy wherein said alkyl and alkoxy are each substituted with 0 to 3 substituents independently selected from F and Cl; (C_1 -C_2)alkoxycarbonyl; (C_1 -C_2)alkylcarbonyl; and (C_1 -C_2)alkylcarbonyloxy; where:

----p is an integer selected from 0, 1, and 2;

----R^4_a and R^4_b are each independently selected from hydrogen and (C_1-C_2)alkyl;

---the moiety represented by partial Formula (1.0.1):



(1.0.1)

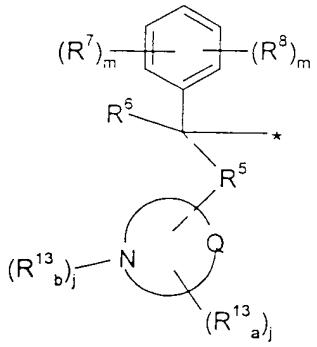
in partial Formula (1.0.0) represents a monocyclic heterocyclic group, or a bicyclic benzo-fused ring system containing said heterocyclic group wherein said heterocyclic group contains a total of 5- or 6- members of which one or two of said members is nitrogen, the presence of the optional second nitrogen atom being represented by: "[N]"; wherein said heterocyclic group or ring system are selected from the group consisting of pyrrolyl; pyrazolyl; imidazolyl; pyridinyl; pyrazinyl; pyrimidinyl; pyridazinyl; piperazinyl; indolyl; indazolinyl; benzimidazolyl; quinolinyl; *iso*-quinolinyl; and quinazolinyl; wherein:

----R^{12}_a is a member selected from the group consisting of hydrogen; F; Cl; $-CO_2R^4$; oxo; -OH; CN; NH_2; $NH(C_1-C_2)$alkyl; $N(C_1-C_2)_2$dialkyl; $-CF_3$; (C_1-C_4)alkyl; (C_2-C_4)alkenyl; (C_1-C_4)alkoxy; (C_3-C_7)cycloalkyl; and phenyl; wherein said alkyl, alkenyl, alkoxy, cycloalkyl and phenyl are substituted with 0 to 2 substituents R^9 where:

-----R^9 is a member independently selected from the group consisting of F; Cl; $-CO_2R^4$; -OH; cyano; $-CONR^4_aR^4_b$; $-NR^4_aR^4_b$-; $-NR^4_aC(=O)R^4_b$; $-NR^4_aC(=O)OR^4_b$; $-NR^4_aS(=O)_pR^4_b$; $-S(=O)_pNR^4_aR^4_b$; (C_1-C_4)alkyl including dimethyl, and (C_1-C_4)alkoxy wherein said alkyl and alkoxy are each independently substituted with 0 to 3 substituents independently selected from F and Cl; (C_1-C_2)alkoxycarbonyl; (C_1-C_2)alkylcarbonyl; and (C_1-C_2)alkylcarbonyloxy; and

----R^{12}_b is absent or is a member selected from the group consisting of hydrogen; (C_1-C_4)alkyl; (C_2-C_4)alkenyl; (C_1-C_2)alkoxy; (C_3-C_7)cycloalkyl; and phenyl; wherein said alkyl, alkenyl, alkoxy, cycloalkyl and phenyl are substituted with 0 to 2 substituents R^9 wherein R^9 has the same meaning as above, except that it is selected independently selected therefrom; and

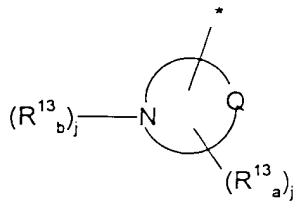
2. hetero-phenylmethylene moieties of partial Formula (1.1.0):



(1.1.0)

---wherein: the symbol " * "; R^5; R^6; R^7; R^8; j and m are as defined further above, except that all of the above-recited substituents are selected independently of their selection above;

---the moiety represented by partial Formula (1.1.1):



(1.1.1)

in partial Formula (1.1.0) represents:

----a. a monocyclic heterocyclic group containing a total of 5 or 6 members of which one said member is nitrogen and Q is selected from O and S where said S may optionally be in the sulfonate form, $-S(=O)_2$; wherein said heterocyclic group is selected from the group consisting of oxazolyl; oxazolidinyl; *iso*xazolyl; thiazolyl; thiazolidinyl; *iso*-thiazolyl; morpholinyl; and thiomorpholinyl; or

----b. a monocyclic heterocyclic group containing a total of 5- or 6- member s of which two said members are nitrogen and a third or fourth said member is independently selected from N, O, and S where said S may optionally be in the sulfonate form, $-S(=O)_2$; wherein said heterocyclic group is selected from the group consisting of triazolyl; triazinyl; tetrazolyl; oxadiazolyl; thiadiazolyl; and

----$R^{13}{}_a$ is selected from the group consisting of hydrogen; F; Cl; $-CO_2R^4$; oxo; -OH; CN; NH_2; $NH(C_1\text{-}C_2)$alkyl; $N(C_1\text{-}C_2)_2$dialkyl; $-CF_3$; $(C_1\text{-}C_4)$alkyl; $(C_2\text{-}C_4)$alkenyl; $(C_1\text{-}C_2)$alkoxy; $(C_3\text{-}C_7)$cycloalkyl; and phenyl; wherein said alkyl, alkenyl, alkoxy, cycloalkyl and phenyl are substituted with 0 to 2 substituents R^{11} where:

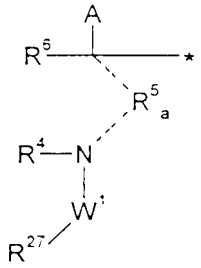
-----R^{11} is a member selected from the group consisting of F; Cl; $-CO_2R^4$; -OH; -CN; $-CONR^4{}_aR^4{}_b$; $-NR^4{}_aR^4{}_b$; $-NR^4{}_aC(=O)R^4{}_b$; $-NR^4{}_aC(=O)OR^4{}_b$; $-NR^4{}_aS(=O)_pR^4{}_b$;

$-S(=O)_pNR^4_aR^4_b$; (C_1-C_4)alkyl including dimethyl, and (C_1-C_4)alkoxy wherein said alkyl and alkoxy are each independently substituted with 0 to 3 substituents independently selected from F and Cl; (C_1-C_2)alkoxycarbonyl; (C_1-C_2)alkylcarbonyl; and (C_1-C_2)alkylcarbonyloxy; and

----R^{13}_b is a member selected from the group consisting of hydrogen; (C_1-C_4)alkyl; (C_2-C_4)alkenyl; (C_1-C_2)alkoxy; (C_3-C_7)cycloalkyl; $C(=O)(C_1-C_4)$alkyl; $S(=O)_2(C_1-C_4)$alkyl; and phenyl; wherein said alkyl, alkenyl, alkoxy, cycloalkyl and phenyl are substituted with 0 to 2 substituents R^{11} wherein R^{11} has the same meaning as in above, except that it is selected independently;

-B. a (substituted)-amido-aryl or -heterocyclyl moiety selected from the group consisting of

--1. alkyl-, alkenyl-, and alkynyl-substituted-amido-aryl moieties of partial Formula (2.0.0):

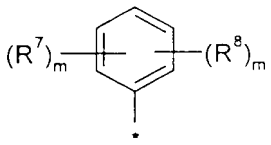


(2.0.0)

---wherein: the symbol " * "; R^4 and R^6; are as defined above, except that all of the above-recited substituents are selected independently of their selection above;

---A is a member selected from the group consisting of:

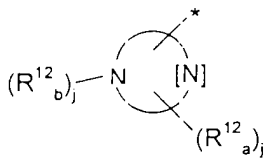
----1. the moiety of partial Formula (2.0.3)



(2.0.3)

-----wherein: the symbol R^7; R^8 and m are as defined above, except that all of the above-recited substituents are selected independently of their selection above; and the symbol: " * " indicates the point of attachment of the moiety A to the, remaining portions of partial Formula (2.0.0);

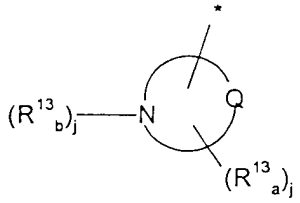
----2. the moiety of partial Formula (2.0.4)



(2.0.4)

which represents a monocyclic heterocyclic group, selected from the group consisting of pyrrolyl; pyrazolyl; imidazolyl; pyridinyl; pyrazinyl; pyrimidinyl; wherein: the symbol $R^{12}{}_a$ and $R^{12}{}_b$ are as defined above, except that all of the above-recited substituents are selected independently of their selection above; and the symbol: " * " indicates the point of attachment of the moiety A to the other, remaining portions of partial Formula (2.0.0);

----3. the moiety of partial Formula (2.0.5)



(2.0.5)

which represents

----a. a monocyclic heteroaromatic group containing a total of 5- members of which one said member is nitrogen and Q is selected from O and S where said S may optionally be in the sulfonate form, $-S(=O)_2$; selected from the group consisting of oxazolyl; *iso*xazolyl; thiazolyl; and *iso*-thiazolyl; or

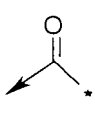
-----b. a monocyclic heterocyclic group containing a total of 5- or 6- members of which two said members are nitrogen and a third or fourth said member is independently selected from N, O, and S where said S may optionally be in the sulfonate form, $-S(=O)_2$; selected from the group consisting of triazolyl; triazinyl; tetrazolyl; oxadiazolyl; and thiadiazolyl; and

------wherein: the $R^{13}{}_a$, $R^{13}{}_b$ and j are as defined above, except that all of the above-recited substituents are selected independently of their selection above; and the symbol: " * " indicates the point of attachment of the moiety A to the other, remaining portions of partial Formula (2.0.2);

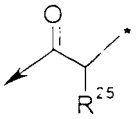
---$R^5{}_a$ is a member selected from the group consisting of a direct bond; -C(=O)-; and $-S(=O)_2-$;

---W^1 is (1.) a direct bond; (2.) in the case where $R^5{}_a$ is -C(=O)- or $-S(=O)_2$, W^1 is a direct bond or $-(C_1-C_3)$alkylene- wherein any single carbon atom thereof is substituted by 0 to 2 substituents R^{23} where R^{23} is a member selected from the group consisting of -F; -Cl;

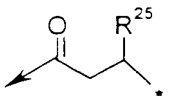
$-CO_2R^4$; -OH; -CN; $(C_1$ -$C_4)$alkoxy; $(C_3$ -$C_7)$cycloalkyl; and phenyl; wherein said alkoxy, cycloalkyl, and phenyl are substituted with 0 to 2 substituents R^{11}, wherein said R^{11} is as defined above, except that all of the above-recited substituents are selected independently of their selection above; or (3.) is a member independently selected from the group consisting of the moieties of partial Formulas (2.0.6) through (2.0.16), inclusive:



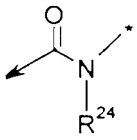
(2.0.6)



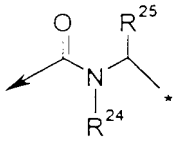
(2.0.7)



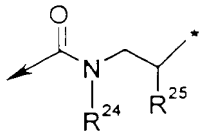
(2.0.8)



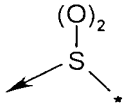
(2.0.9)



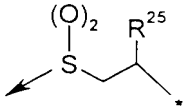
(2.0.10)



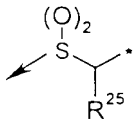
(2.0.11)



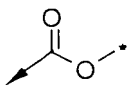
(2.0.12)



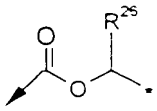
(2.0.13)



(2.0 14)



(2.0.15)



(2.0.16)

----wherein: the symbol: "→" indicates the point of attachment of the moiety W^1 to the nitrogen atom in partial Formula (2.0.0), and the symbol: " * " indicates the point of attachment of the moiety W^1 to the other, remaining portions of partial Formula (2.0.0); and R^4 is as defined further above, but selected on an independent basis;

--------R^{24} is selected from the group consisting of hydrogen and $(C_1$-$C_4)$alkyl; and

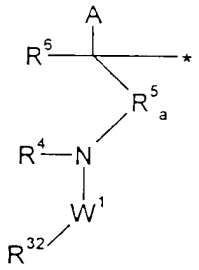
----R^{25} and R^{26} are each selected from the group consisting of -OH; $(C_1$.$C_2)$alkyl substituted by 0 to 3 substituents selected from F; and OH; and $(C_1$.$C_2)$alkoxy; and

---R^{27} is selected from the group consisting of $(C_1$.$C_6)$alkyl; $(C_2$.$C_6)$alkenyl; and $(C_2$.$C_6)$alkynyl; wherein said alkyl, alkenyl, and alkynyl groups comprising R^{27} are substituted with 0 to 3 substituents R^{28} where:

----R^{28} is selected from the group consisting of phenyl; F or Cl; oxo; hydroxy; $(C_1$.$C_2)$alkyl; $(C_1$.$C_3)$alkoxy; $-C(=O)OR^{29}$; $-C(=O)(C_1$-$C_4)$alkyl; $-S(=O)_2(C_1$-$C_4)$alkyl; $-C(=O)NR^{29}R^{30}$; $-NR^{29}R^{30}$; $-NR^{29}C(=O)R^{30}$; $-NR^{29}C(=O)OR^{30}$; $-NR^{29}S(=O)_pR^{30}$; and $-S(=O)_2NR^{29}R^{30}$, where:

-----R^{29} and R^{30} are each a member independently selected from the group consisting of hydrogen and (C_1 .C_4)alkyl substituted by 0 to 3 substituents selected from the group consisting of F and Cl;

--2. cycloalkyl-substituted-amido-aryl moieties of partial Formula (2.1.0):

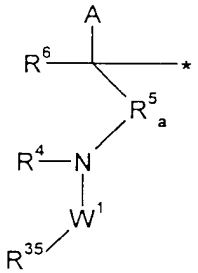


(2.1.0)

—wherein: A; W^1; the symbol " * "; R^4; $R^5{}_a$; and R^6 have the same meaning as set out above, except that all of the above-recited substituents are selected independently of their selection above; and

—R^{32} is a member selected from the group consisting of -$(CH_2)_n$-(C_3 .C_7)cycloalkyl, where n is an integer selected from 0, 1, and 2; in the event n is 0, then the α-carbon atom of said (C_3 .C_7)cycloalkyl is substituted by 0 or 1 (C_1 .C_4)alkyl or phenyl, where said alkyl or phenyl are substituted by 0, 1, or 2 of CH_3, OCH_3, OH or NH_2; and in the event that n is 1 or 2, the resulting methylene or ethylene is substituted by 0 or 1 of F; NH_2; $N(CH_3)_2$; OH; OCH_3; (C_1 .C_4)alkyl; or phenyl; where said alkyl and phenyl are substituted by 0, 1, or 2 of CH_3, OCH_3, OH, and NH_2; and further wherein said (C_3 .C_7)cycloalkyl is substituted by 0 to 3 substituents R^{28} where R^{28} is as defined further above, but selected independently

--3. aryl and heterocyclic-substituted-amido-aryl moieties of partial Formula (2.2.0):

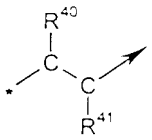


(2.2.0)

—wherein: A; W^1; the symbol: " * "; R^4; $R^5{}_a$; and R^6 have the same meaning as set out above, except that all of the above-recited substituents are selected independently of their selection above; and

---R^{35} is selected from the group consisting of phenyl; furyl; tetrahydrofuranyl; tetrahydropyranyl; oxetanyl; thienyl; pyrrolyl; pyrrolidinyl; oxazolyl; isoxazolyl; thiazolyl; isothiazolyl; imidazolyl; pyrazolyl; oxadiazolyl; thiadiazolyl; triazolyl; pyridyl; pyrazinyl; pyridazinyl; piperazinyl; pyrimidinyl; pyranyl; azetidinyl; morpholinyl; parathiazinyl; indolyl; indolinyl; benzo[*b*]furanyl; 2;3-dihydrobenzofuranyl; benzothienyl; 1H-indazolyl; benzimidazolyl; benzoxazolyl; benzisoxazolyl; benzthiazolyl; quinolinyl; isoquinolinyl; phthalazinyl; quinazolinyl; and quinoxalinyl; wherein (1.) said group R^{35} may be substituted upon any one or more carbon atoms thereof by 0 to 3 substituents R^{28} where R^{28} is as defined above, except that it is selected independently; (2.) said group R^{35} is substituted with respect to any one or more nitrogen atoms thereof that is not a point of attachment of said aryl or heterocyclic moiety, by 0 to 3 substituents $R^{13}{}_b$ where $R^{13}{}_b$ is as defined above, except that it is selected independently; and (3.) said group R^{35} with respect to any sulfur atom thereof that is not a point of attachment of said heterocyclic moiety, is substituted by 0 or 2 oxygen atoms;

[R_{egion} β] is an alkyl bridging element of partial Formula (3.0.0):



(3.0.0)

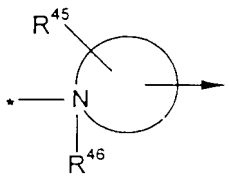
wherein:

--" * " is a symbol which represents the point of attachment of the moiety of partial Formula (3.0.0) to R_{egion} α;

--"→" is a symbol which represents the point of attachment of the moiety of partial Formula (3.0.0) to R_{egion} γ;

--R^{40} and R^{41} are both selected from the group consisting of hydrogen; (C_1-C_2) alkyl including dimethyl; hydroxy; and (C_1-C_3) alkoxy;

[R_{egion} γ] is an aza-monocyclic moiety of partial Formula (4.0.0):



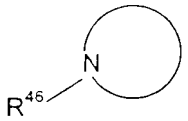
(4.0.0)

–wherein:

--" * " is a symbol which represents the point of attachment of the moiety of partial Formula (4.0.0) to R_{egion} β of the compound of Formula (I);

--"*→*" is a symbol representing a covalent bond attaching any carbon atom of said aza-monocyclic moiety of partial Formula (4.0.0) to R_{egion} δ;

--the moiety of partial Formula (4.0.1):



(4.0.1)

in partial Formula (4.0.0) represents a monocyclic heterocyclic group containing a total of from 4- to 7-members of which one said member is nitrogen, wherein said heterocyclic group is a member independently selected from the group consisting essentially of azetidinyl; pyrrolidinyl; piperidinyl; and azepinyl;

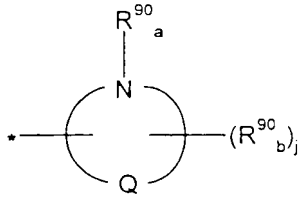
$-R^{45}$ is absent or is a member independently selected from the group consisting essentially of $(C_1\text{-}C_4)$alkyl including dimethyl; $(C_3\text{-}C_6)$cycloalkyl; $(C_1\text{-}C_4)$alkoxy; $(C_1\text{-}C_2)$alkoxy(C1-C2)alkyl; CF_3; $-CO_2R^4$ where R^4 is as defined further above; oxo; -OH; cyano; $-C(=O)NR^4{}_aR^4{}_b$; $-NR^4{}_aR^4{}_b$; $-NR^4{}_aC(=O)R^4{}_b$; $-NR^4{}_aC(=O)OR^4{}_b$; $-NR^4{}_aS(=O)_pR^4{}_b$; $-S(=O)_pNR^4{}_aR^4{}_b$; $(C_1\text{-}C_2)$alkoxycarbonyl; $(C_1\text{-}C_2)$alkylcarbonyl; $(C_1\text{-}C_2)$alkylcarbonyloxy; and $(C_1\text{-}C_2)$alkoxy$(C_1\text{-}C_2)$alkyl; it being understood that in the moiety of partial Formula (4.0.0) R^{45} is a substituent attached to a single carbon atom thereof; where:

---$R^4{}_a$ and $R^4{}_b$ are each independently selected from hydrogen and $(C_1\text{-}C_2)$alkyl;

$-R^{46}$ is absent or is a member independently selected from the group consisting essentially of hydrogen; and $(C_1\text{-}C_4)$alkyl substituted by 0 or 1 substituent independently selected from $(C_1\text{-}C_2)$alkoxy and $-CO_2R^4$ where R^4 is as defined further above; and =O; it being understood that in the case where substituent R^{46} is chosen to be other than absent, that it results in said nitrogen atom and said moiety of partial Formula (4.0.0) being in quaternary form;

[R_{egion} δ] is a (substituted)-heterocyclyl moiety selected from the group consisting of:

--1. a heterocyclyl moiety of partial Formula (5.3.0):



(5.3.0)

--wherein: the symbol: " * " indicates the point of attachment of partial Formula (5.3.0) to $R_{eg.ion\ \gamma}$; Q is N, O or S and

--partial Formula (5.3.0) represents:

---a. a monocyclic heterocyclic group containing a total of 5- members of which one said member is nitrogen and a second said member is selected from O and S where said S may optionally be in the sulfonate form, wherein said heterocyclic group is selected from the group consisting of oxazolyl; *iso*xazolyl; thiazolyl; and *iso*-thiazolyl; or

---b. a monocyclic heterocyclic group containing a total of 5- members of which two said members are nitrogen and a third or fourth said member is independently selected from N, O, and S where said S may optionally be in the sulfonate form, $-S(=O)_2$; wherein said heterocyclic group is independently selected from the group consisting of triazolyl; triazinyl; tetrazolyl; oxadiazolyl; and thiadiazolyl; and

--$R^{90}{}_a$ and $R^{90}{}_b$ are each a member independently selected from the group consisting of hydrogen, $-(C_1\text{-}C_2)$alkylcarbonyl; $-(C_1\text{-}C_4)$alkyl; $-(CH_2)_n\text{-}(C_3\text{-}C_7)$cycloalkyl; $-(C_2\text{-}C_3)$alkenyl; $-(CH_2)_n\text{-}$(phenyl); and $-(CH_2)_n\text{-}(HET_1)$, where n is an integer independently selected from 0, 1, and 2; wherein said $(C_1\text{-}C_4)$alkyl, alkenyl, cycloalkyl, phenyl, and HET_1 groups are independently substituted with 0 to 3 substituents R^{91}, where:

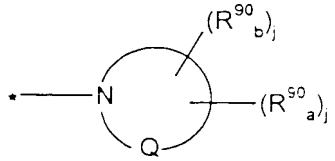
---j has the same meaning as set forth above, but is selected on an independent basis therefrom;

---HET_1 is a heterocyclyl group selected from the group consisting of thienyl; oxazolyl; isoxazolyl, thiazolyl, isothiazolyl, pyrazolyl, oxadiazolyl, thiadiazolyl, triazolyl, pyridyl, pyrazinyl, pyridazinyl; pyrimidinyl; parathiazinyl; and morpholinyl; where:

----R^{91} is selected from the group consisting of -F; -Cl; $-CO_2R^4$; -oxo; -OH; -CN; $-CONR^{93}R^{94}$; $-NR^{93}R^{94}$; $C(=O)(C_1\text{-}C_4)$alkyl; $-NR^{93}C(=O)R^{94}$; $-NR^{93}C(=O)OR^{94}$; $-NR^{93}S(=O)R^{94}$; $-S(=O)NR^{93}R^{94}$; $(C_1\text{-}C_4)$alkyl, and $(C_1\text{-}C_4)$alkoxy wherein said alkyl and alkoxy are each independently substituted with 0 to 3 substituents independently selected from F and Cl; $(C_1\text{-}C_2)$alkoxycarbonyl; $(C_1\text{-}C_2)$alkylcarbonyl; and $(C_1\text{-}C_2)$alkylcarbonyloxy; wherein:

-----R^{93} and R^{94} are each a member independently selected from the group consisting of hydrogen; and $(C_1\text{-}C_2)$alkyl; and

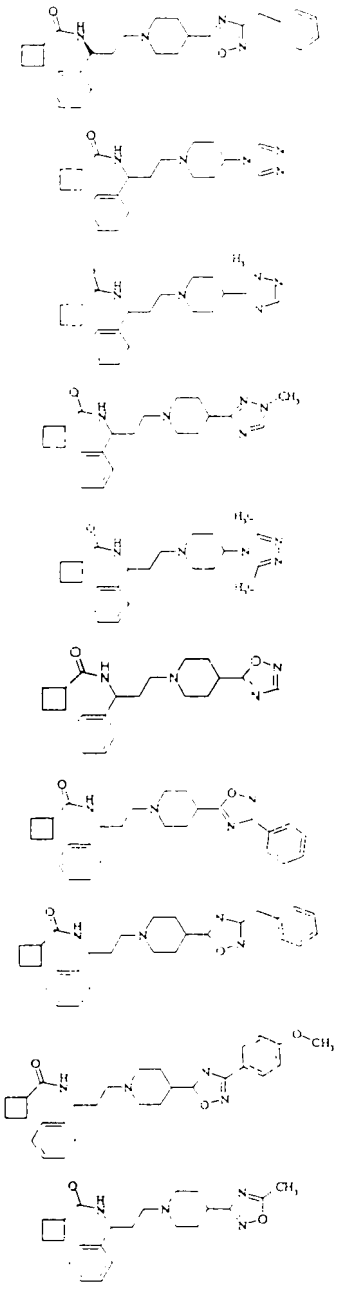
--2. a heterocyclyl moiety of partial Formula (5.4.0):

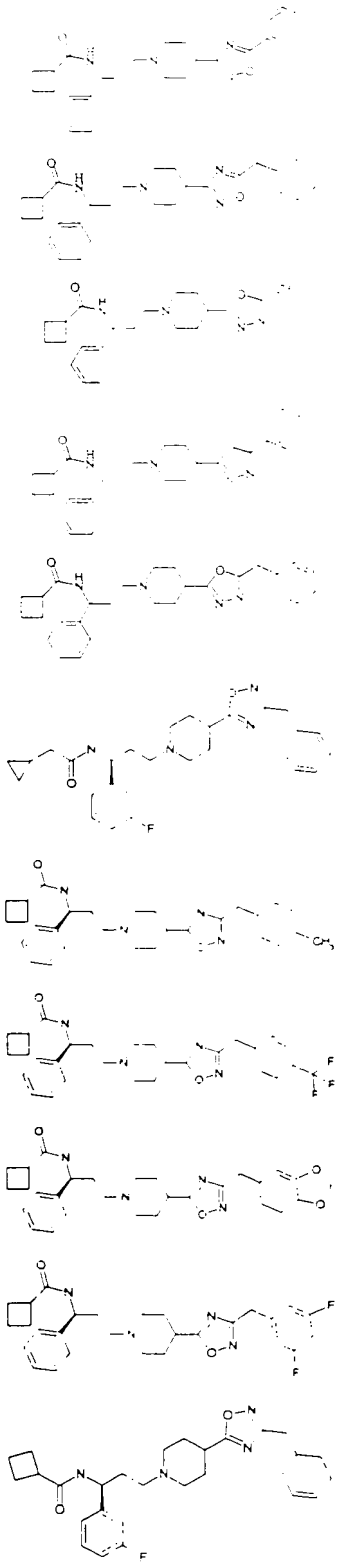


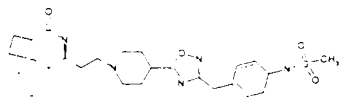
(5.4.0)

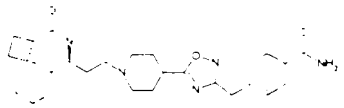
---wherein: $R^{90}{}_a$; $R^{90}{}_b$; and j have the same meanings as set out above, but are selected independently.

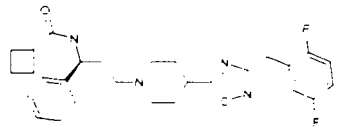
2. A compound which is selected from the group consisting of

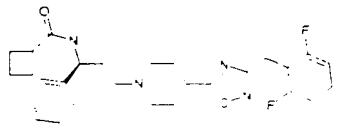


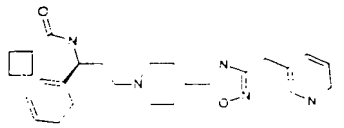


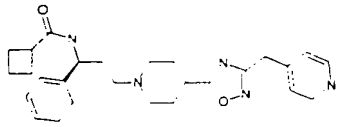


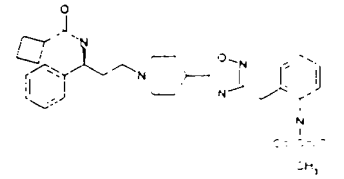


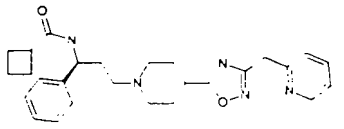


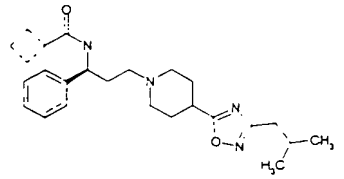


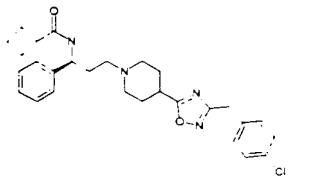


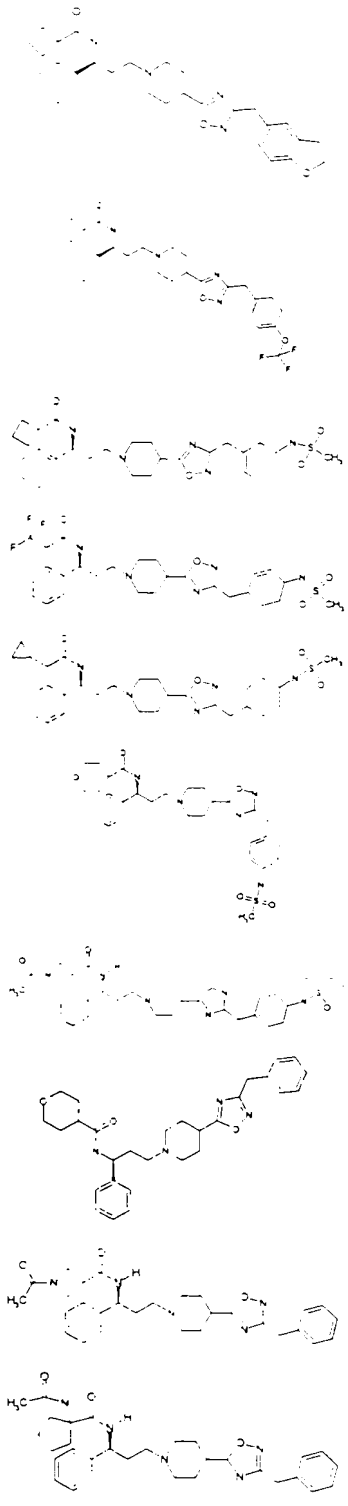


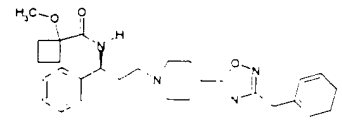


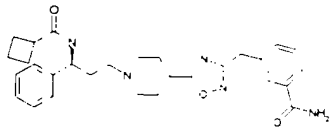


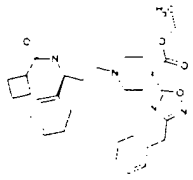


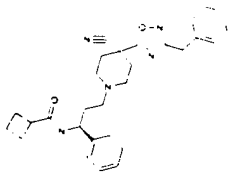


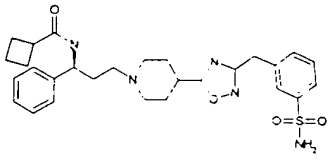


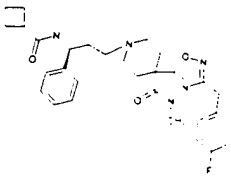


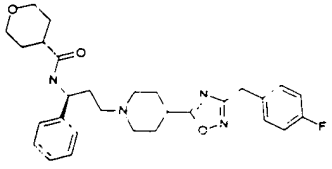


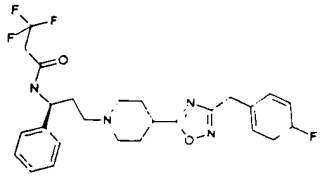


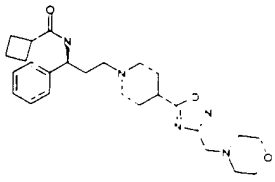


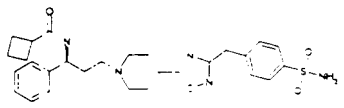


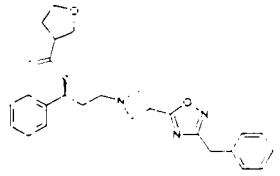


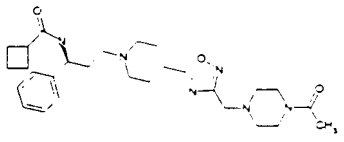


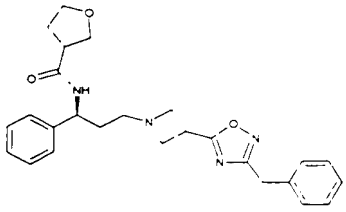


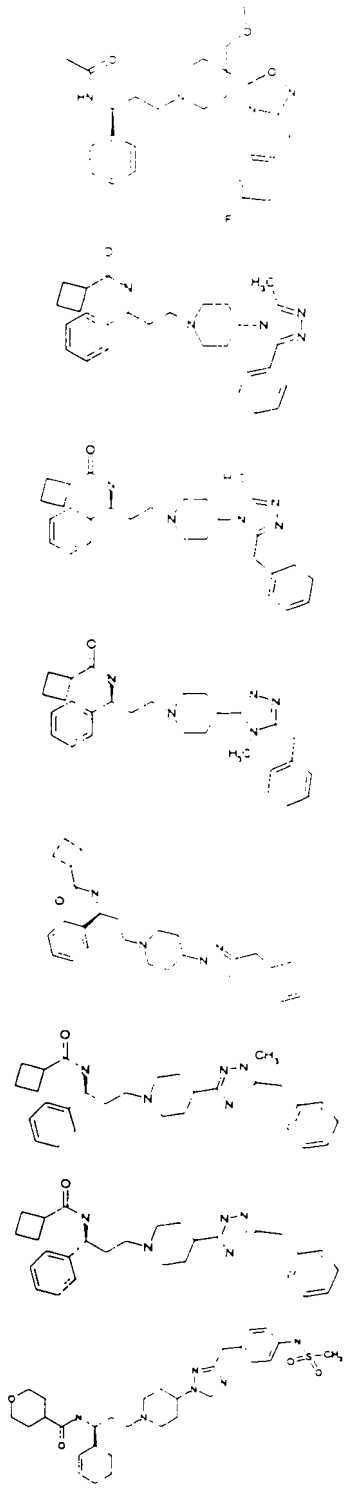


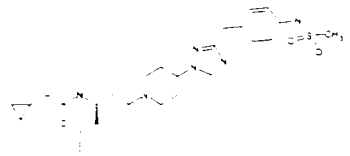


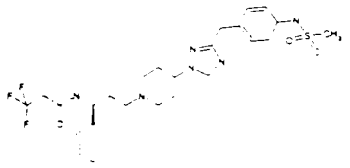


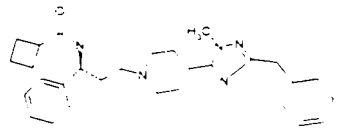


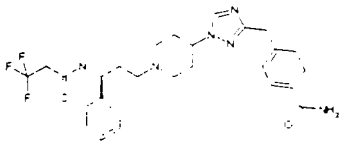


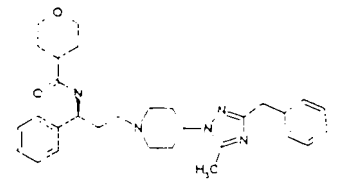


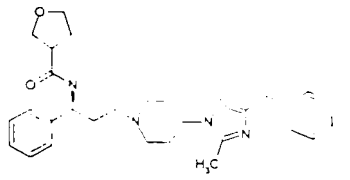


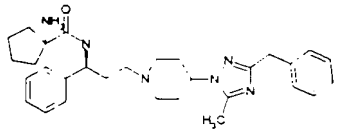


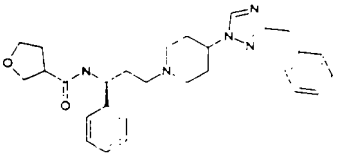


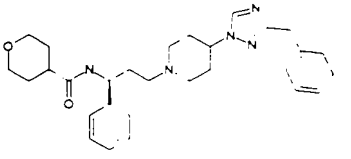


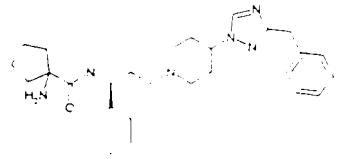


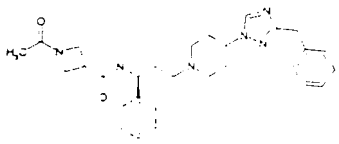


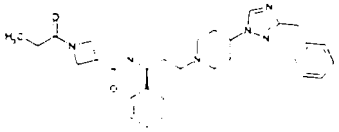


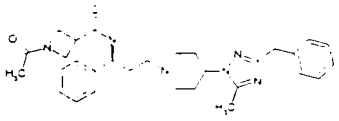


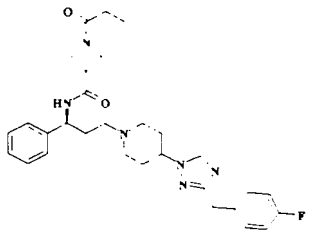


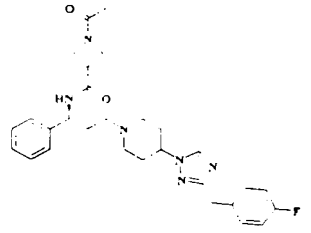


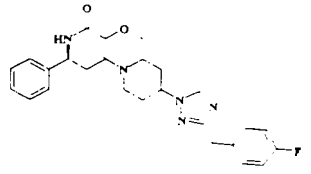


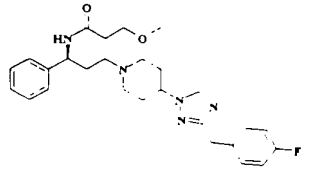












3. A compound which is selected from the group consisting of:

N-{(1*S*)-3-[4-(3-Benzyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide

N-{1-Phenyl-3-[4-(4*H*-1,2,4-triazol-4-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide

N-{3-[4-(1-Methyl-1*H*-1,2,4-triazol-5-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide

N-{3-[4-(1-Methyl-1*H*-1,2,4-triazol-3-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide

N-{3-[4-(3,5-Dimethyl-4*H*-1,2,4-triazol-4-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide

N-{1-Phenyl-3-[4-(3-methyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]propyl}cyclobutanecarboxamide

N-{1-Phenyl-3-[4-(3-phenyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]propyl}cyclobutanecarboxamide

N-{3-[4-(3-Benzyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide

N-(3-{4-[3-(4-Methoxyphenyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)cyclobutanecarboxamide

N-{3-[4-(5-Methyl-1,2,4-oxadiazol-3-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide

N-{1-Phenyl-3-[4-(5-phenyl-1,2,4-oxadiazol-3-yl)-1-piperidinyl]propyl}cyclobutanecarboxamide

N-{3-[4-(5-Benzyl-1,2,4-oxadiazol-3-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide

N-{3-[4-(5-Methyl-1,3,4-oxadiazol-2-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide

N-{1-Phenyl-3-[4-(5-phenyl-1,3,4-oxadiazol-2-yl)-1-piperidinyl]propyl}cyclobutanecarboxamide

N-{3-[4-(5-Benzyl-1,3,4-oxadiazol-2-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide

N-[(1*S*)-3-[4-(3-Benzyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-(3-fluorophenyl)propyl]-2-cyclopropylacetamide

N-((1*S*)-3-{4-[3-(4-Methylbenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)cyclobutanecarboxamide

N-((1*S*)-3-{4-[3-(4-Trifluoromethylbenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)cyclobutanecarboxamide

N-((1*S*)-3-{4-[3-(1,3-Benzodioxol-5-ylmethyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)cyclobutanecarboxamide (UK-383290-51)

N-((1*S*)-3-{4-[3-(3,5-Difluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)cyclobutanecarboxamide

N-[(1*S*)-3-[4-(3-Benzyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-(3-fluorophenyl)propyl]cyclobutanecarboxamide

N-{(1*S*)-3-[4-(3-{4-[(Methylsulfonyl)amino]benzyl}-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide

4-{[5-(1-{(3*S*)-3-[(Cyclobutylcarbonyl)amino]-3-phenylpropyl}-4-piperidinyl)-1,2,4-oxadiazol-3-yl]methyl}benzamide

N-((1*S*)-3-{4-[3-(2,5-Difluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)cyclobutanecarboxamide (UK-384644-51)

N-((1*S*)-3-{4-[3-(2,6-Difluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)cyclobutanecarboxamide (UK-384647-51)

N-((1*S*)-1-Phenyl-3-{4-[3-(3-pyridinylmethyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}propyl)cyclobutanecarboxamide

N-((1*S*)-1-Phenyl-3-{4-[3-(4-pyridinylmethyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}propyl)cyclobutanecarboxamide

N-{(1*S*)-3-[4-(3-{2-[(Methylsulfonyl)amino]benzyl}-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide

N-((1*S*)-1-Phenyl-3-{4-[3-(2-pyridinylmethyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}propyl)cyclobutanecarboxamide

N-((1*S*)-3-[4-(3-Isobutyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide

N-((1*S*)-3-{4-[3-(3-Chlorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)cyclobutanecarboxamide

N-((1*S*)-3-{4-[3-(1-Benzofuran-5-ylmethyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)cyclobutanecarboxamide

N-[(1*S*)-1-Phenyl-3-(4-{3-[4-(trifluoromethoxy)benzyl]-1,2,4-oxadiazol-5-yl}-1-piperidinyl)propyl]cyclobutanecarboxamide

N-{(1*S*)-3-[4-(3-{3-[(Methylsulfonyl)amino]benzyl}-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide

3,3,3-Trifluoro-*N*-{(1*S*)-3-[4-(3-{4-[(methylsulfonyl)amino]benzyl}-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}propanamide

2-Cyclopropyl-*N*-{(1*S*)-3-[4-(3-{4-[(methylsulfonyl)amino]benzyl}-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}acetamide

N-{(1*S*)-3-[4-(3-{4-[(Methylsulfonyl)amino]benzyl}-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}tetrahydro-2*H*-pyran-4-carboxamide

1-Acetyl-*N*-{(1*S*)-3-[4-(3-{4-[(methylsulfonyl)amino]benzyl}-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}-3-azetidinecarboxamide

N-{(1*S*)-3-[4-(3-Benzyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}tetrahydro-2*H*-pyran-4-carboxamide

1-Acetyl-*N*-{(1*S*)-3-[4-(3-benzyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}-3-azetidinecarboxamide

1-(Acetylamino)-*N*-{(1*S*)-3-[4-(3-benzyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}cyclopentanecarboxamide

N-{(1*S*)-3-[4-(3-Benzyl-1,2,4-oxadiazol-5-yl)-1-piperidinyl]-1-phenylpropyl}-1-methoxycyclobutanecarboxamide

3-{[5-(1-{(3*S*)-3-[(Cyclobutylcarbonyl)amino]-3-phenylpropyl}-4-piperidinyl)-1,2,4-oxadiazol-3-yl]methyl}benzamide

Ethyl 4-(3-benzyl-1,2,4-oxadiazol-5-yl)-1-{(3S)-3-[(cyclobutylcarbonyl)amino]-3-phenylpropyl}-4-piperidinecarboxylate

N-{(1*S*)-3-[4-(3-Benzyl-1,2,4-oxadiazol-5-yl)-4-cyano-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide

N-[(1*S*)-3-(4-{3-[3-(Aminosulfonyl)benzyl]-1,2,4-oxadiazol-5-yl}-1-piperidinyl)-1-phenylpropyl]cyclobutanecarboxamide

1-{(3*S*)-3-[(Cyclobutylcarbonyl)amino]-3-phenylpropyl}-4-[3-(4-fluorobenzyl)-1,2,4-oxadiazol-5-yl]-*N*-methyl-4-piperidinecarboxamide

N-((1*S*)-3-{4-[3-(4-Fluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)tetrahydro-2*H*-pyran-4-carboxamide

3,3,3-Trifluoro-*N*-((1*S*)-3-{4-[3-(4-fluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)propanamide

N-((1*S*)-3-{4-[3-(4-Morpholinylmethyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)cyclobutanecarboxamide

N-((1*S*)-3-{4-Cyano-4-[3-(4-fluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)tetrahydro-2*H*-pyran-4-carboxamide

N-((1*S*)-3-{4-Cyano-4-[3-(4-fluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)-2-cyclopropylacetamide

1-Acetyl-*N*-((1*S*)-3-{4-cyano-4-[3-(4-fluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)-3-azetidinecarboxamide

N-((1*S*)-3-{4-Cyano-4-[3-(4-fluorobenzyl)-1,2,4-oxadiazol-5-yl]-1-piperidinyl}-1-phenylpropyl)-3,3,3-trifluoropropanamide

N-[(1*S*)-3-(4-{3-[4-(Aminosulfonyl)benzyl]-1,2,4-oxadiazol-5-yl}-1-piperidinyl)-1-phenylpropyl]cyclobutanecarboxamide

N-{(1*S*)-3-[3-Benzyl-1,2,4-oxadiazol-5-yl)-1-azetidinyl]-1-phenylpropyl}tetrahydro-3-furancarboxamide

N-[(1*S*)-3-(4-{3-[(4-Acetyl-1-piperazinyl)methyl]-1,2,4-oxadiazol-5-yl}-1-piperidinyl)-1-phenylpropyl]cyclobutanecarboxamide

N-{(1*S*)-3-[3-Benzyl-1,2,4-oxadiazol-5-yl)-1-azetidinyl]-1-phenylpropyl}tetrahydro-3-furancarboxamide

N-{(1*S*)-3-[4-[3-(4-Fluorobenzyl)-1,2,4-oxadiazol-5-yl]-4-(methoxymethyl)-1-piperidinyl]-1-phenylpropyl}acetamide

N-{3-[4-(3-Methyl-5-phenyl-4*H*-1,2,4-triazol-4-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide

N-{(1*S*)-3-[4-(3-Benzyl-5-methyl-4*H*-1,2,4-triazol-4-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide

N-{(1*S*)-3-[4-(5-Benzyl-4-methyl-4*H*-1,2,4-triazol-3-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide

N-{(1*S*)-3-[4-(3-Benzyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}-cyclobutanecarboxamide

N-{(1*S*)-3-[4-(5-Benzyl-1-methyl-1*H*-1,2,4-triazol-3-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide

N-{3-[4-(5-Benzyl-1*H*-1,2,4-triazol-3-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide

N-{(1*S*)-3-[4-(3-{4-[(methylsulfonyl)amino]benzyl}-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}tetrahydro-2*H*-pyran-4-carboxamide

2-Cyclopropyl-*N*-{(1*S*)-3-[4-(3-{4-[(methylsulfonyl)amino]benzyl}-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}acetamide

3,3,3-Trifluoro-*N*-{(1*S*)-3-[4-(3-{4-[(methylsulfonyl)amino]benzyl}-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}propanamide

N-(1*S*)-{3-[4-(3-Benzyl-1-methyl-1*H*-1,2,4-triazol-5-yl)-1-piperidinyl]-1-phenylpropyl}cyclobutanecarboxamide

4-{[1-(1-{(3*S*)-3-Phenyl-3-[(3,3,3-trifluoropropanoyl)amino]propyl}-4-piperidinyl)-1*H*-1,2,4-triazol-3-yl]methyl}benzamide

N-{(1*S*)-3-[4-(3-Benzyl-5-methyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}tetrahydro-2*H*-pyran-4-carboxamide

N-{(1*S*)-3-[4-(3-Benzyl-5-methyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}tetrahydro-3-furancarboxamide

1-Amino-*N*-{(1*S*)-3-[4-(3-benzyl-5-methyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}cyclopentanecarboxamide

N-{(1*S*)-3-[4-(3-Benzyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}tetrahydro-3-furancarboxamide

N-{(1*S*)-3-[4-(3-Benzyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}tetrahydro-2*H*-pyran-4-carboxamide

1-Amino-*N*-{(1*S*)-3-[4-(3-benzyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}cyclopentanecarboxamide

1-Acetyl-*N*-{(1*S*)-3-[4-(3-benzyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}-3-azetidinecarboxamide

N-{(1*S*)-3-[4-(3-Benzyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}-1-propionyl-3-azetidinecarboxamide

1-Acetyl-*N*-{(1*S*)-3-[4-(3-benzyl-5-methyl-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}-3-azetidinecarboxamide

N-{(1*S*)-3-[4-(3-(4-Fluorobenzyl)-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}-1-propionyl-3-azetidinecarboxamide

1-Acetyl-*N*-{(1*S*)-3-[4-(3-(4-fluorobenzyl)-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}-3-azetidinecarboxamide

2-Methoxy-*N*-{(1*S*)-3-[4-(3-(4-fluorobenzyl)-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}acetamide

3-Methoxy-*N*-{(1*S*)-3-[4-(3-(4-fluorobenzyl)-1*H*-1,2,4-triazol-1-yl)-1-piperidinyl]-1-phenylpropyl}propanamide

4. A method of treating or preventing a disease or condition mediated by or associated with modulation of CCR5 chemokine receptor activity in a patient which is in need of such treatment or is a prospective beneficiary of such prevention, comprising administering to said patient an amount of a compound claimed in any preceding claim which is therapeutically effective to treat or prevent said disease or condition.

5. A pharmaceutical composition for treating or preventing a disease or condition mediated by or associated with modulation of CCR5 chemokine receptor activity comprising an amount of a compound claimed in any preceding claim which is therapeutically effective to treat or prevent said disease or condition, together with a pharmaceutically acceptable carrier therefor.

6. A method of treating or preventing infection by human immunodeficiency virus (HIV) in a patient which is in need of such treatment or is a prospective beneficiary of such

prevention, including treatment or prevention of acquired immunodeficiency syndrome (AIDS) resulting therefrom, comprising administering to said patient an amount of a compound as claimed in any preceding claim which is therapeutically effective to treat or prevent said infection by HIV, including AIDS.

7. A method according to claim 5 further including coadministering to said patient in combination with a compound as claimed in any of claim 1 to 3, one or more additional therapeutic agents for treating or preventing HIV infection comprising one or more members selected from the group consisting of (1) inhibitors of HIV protease; and (2) inhibitors of HIV reverse transcriptase.

8. A method according to claim 7 wherein: (1) said inhibitors of HIV protease comprise one or more members selected from the group consisting of indinavir, ritonavir, saquinavir, nelfinavir, and amprenavir; and (2) said inhibitors of HIV reverse transcriptase comprise one or more members selected from the group consisting of (a) non-nucleoside reverse transcri8ptase inhibitors (NNRTIs) selected from nevirapine, delavirdine, and efavirenz; and (b) nucleoside/nucleotide inhibitors (NRTIs) selected from zidovudine, didanosine, zalcitabine, stavudine, lamivudine, abacavir, and adefovir dipivoxil.

9. A method according to claim 7 wherein said inhibitors of HIV protease and said inhibitors of HIV reverse transcriptase comprise one or more members selected from the group consisting of indinavir; ritonavir' saquinavir; nelfinavir; amprenavir; nevirapine; elavirdine; efavirenz; zidovudine; didanosine; zalcitabine; stavudine; lamivudine; abacavir; adefovir dipivoxil; FTC; PMPA; fozivudine tidoxil; talviraline; S-1153; MKC-442; MSC-204; MSH-372; DMP450; PNU-140690; ABT-378; and KNI-764.

10. A method according to claim 7 wherein said method comprises preventing HIV infection and said patient being treated is aviremic and/or asymptomatic and is potentially or effectively infected with HIV, comprising administering to said patient a combination of therapeutic agents comprising a member selected from the group consisting of: (i) a compound as claimed in claim 1; (ii) one non-nucleoside reverse transcriptase inhibitor (NNRTI) in addition to a compound of (I); (iii) one nucleoside/nucleotide inhibitor (NRTI) in addition to a compound of (I); (iv) one NRTI in addition to the combination of (ii); and (v) a compound selected from inhibitors of HIV protease used in place of said NRTI in combinations (iii) and (iv).

11. A method according to claim 7 wherein said method comprises treating HIV infection and said patient being treated has detectable viremia or abnormally low CD4 counts,

comprising administering to said patient a combination of therapeutic agents comprising (A) a member selected from the group consisting of a compound of Formula (I) as defined in claim 1; and a therapeutic agent comprising one protease inhibitor in combination with two NRTIs; or (B) the combination of therapeutic agents recited in (A) where either said protease inhibitor component, or one or both of said NRTIs is/are replaced by a compound of Formula (I) as defined in claim 1.

12. A method according to claim 7 wherein said method comprises treating HIV-infected individuals that have failed antiviral therapy comprising adminstering to said patient a combination of therapeutic agents comprising (A) a member selected from the group consisting of a compound as claimed in claim 1; or (B) a therapeutic agent comprising one protease inhibitor in combination with two NRTIs where either said protease inhibitor component, or one or both of said NRTIs is/are replaced by a compound of Formula (I) as defined in claim 1.

13. A method according to claim 8 further comprising coadministering with said compound of Formula (I) as defined in claim 1 one or more supplementary therapeutic agents which provide auxiliary treatment of diseases or conditions directly resulting from or indirectly accompanying infection by HIV, including AIDS resulting therefrom, wherein said supplementary therapeutic agent is one or more members selected from the group consisting of proliferation inhibitors; immunomodulators; interferon or interferon derivatives; fusion inhibitors; integrase inhibitors; RnaseH inhibitors; and inhibitors of viral transcription and RNA replication.

14. A method according to claim 13 wherein said proliferation inhibitor is hydroxyurea; said immunomodulator is sargramostim; said fusion inhibitor is AMD3100, T-20, PRO-542, AD-349, or BB-10010; and said integrase inhibitor is AR177.

15. A pharmaceutical composition for treating or preventing infection by human immunodeficiency virus (HIV) in a patient which is in need of such treatment or is a prospective beneficiary of such prevention, including treatment or prevention of acquired immunodeficiency syndrome (AIDS) resulting therefrom, comprising an amount of a compound as claimed in claim 1 which is therapeutically effective to treat or prevent said infection by HIV or AIDS resulting therefrom, together with a pharmaceutically acceptable carrier therefor.

16. A pharmaceutical composition according to claim 15 further including in combination with a compound of Formula (I) as claimed in claim 1, one or more additional

therapeutic agents for treating or preventing HIV infection comprising one or more members independently selected from the group consisting essentially of (1) inhibitors of HIV protease; and (2) inhibitors of HIV reverse transcriptase.

17. A pharmaceutical composition according to claim 16 wherein: (1) said inhibitors of HIV protease comprise one or more members independently selected from the group consisting of indinavir, ritonavir, saquinavir, nelfinavir, and amprenavir; and (2) said inhibitors of HIV reverse transcriptase comprise one or more members selected from the group consisting of (a) non-nucleoside reverse transcriptase inhibitors selected from nevirapine, delavirdine, and efavirenz; and (b) nucleoside/nucleotide inhibitors selected from zidovudine, didanosine, zalcitabine, stavudine, lamivudine, abacavir, and adefovir dipivoxil.

18. A pharmaceutical composition according to claim 16 wherein said inhibitors of HIV protease and said inhibitors of HIV reverse transcriptase comprise one or more members selected from the group consisting of indinavir; ritonavir; saquinavir; nelfinavir; amprenavir; nevirapine; delavirdine; efavirenz; zidovudine; didanosine; zalcitabine, stavudine; lamivudine; abacavir; adefovir dipivoxil; FTC; PMPA; fozivudine todoxil; talviraline; S-1153; MKC-442; MSC-204; MSH-372; DMP450; PNU-140690; ABT-378; and KNI-764.

19. A pharmaceutical composition according to claim 15 further comprising coadministering with said compound of Formula (1) as defined in claim 1 one or more supplementary therapeutic agents which provide auxiliary treatment of diseases or conditions directly resulting from or indirectly accompanying infection by HIV, including AIDS resulting therefrom, wherein said supplementary therapeutic agent is one or more members selected from the group consisting of proliferation inhibitors; immunomodulators; interferon or interferon derivatives; fusion inhibitors; integrase inhibitors; RNaseH inhibitors; and inhibitors of viral transcription and RNA replication.

20. A pharmaceutical composition according to claim 19 wherein said proliferation inhibitor is hydroxyurea; said immunomodulator is sargramostim; said fusion inhibitor is AMD3100, T-20, PRO-542, AD-349 or BG-10010; and said integrase inhibitor is AR177.

21. A method of evaluating a putative HIV retrovirus mutant for resistance to anti-HIV therapeutic agents, comprising isolating said putative mutant virus from an *in vitro* culture thereof; an *in vitro* animal infection model thereof; or from patient samples where said patient is undergoing optimal or sub-optimal treatment comprising administration of a compound as defined in claim 1, alone or together in any combination thereof with one or more therapeutic agents for treating or preventing HIV infection.

22. A mutant HIV virus or component part thereof, prepared in accordance with the procedures of claim 21.

23. A mutant HIV virus or component thereof according to claim 21 wherein said component is the complete envelope protein thereof, or infections fragment thereof.

24. A method of discovering the presence of, and/or confirming the activity of a chemokine modulator having activity against a mutant HIV virus, comprising using as a probe for effecting said discovery and/or confirmation a mutant HIV virus or component thereof according to claim 21.

25. A diagnostic agent for use in choosing a therapeutic regimen and/or predicting the outcome for a patient being treated for infection by a mutant HIV virus, wherein said diagnostic agent comprises a mutant HIV virus or component thereof according to claim 21.

26. A pharmaceutical composition for treating or preventing a respiratory disease or condition comprising an amount of a compound claimed in any of claims 1 to 3 which is effective to treat said disease or condition, together with a pharmaceutically effective carrier therefor.

27. A compound as claimed in claims 1 to 3 in purified form.

28. A pharmaceutical composition comprising a compound as claimed in claims 1 to 3 and one or more inert excipients.

ABSTRACT

Compounds of Formula 1

$$[R_{egion\ \alpha}] - [R_{egion\ \beta}] - [R_{egion\ \gamma}] - [R_{egion\ \delta}] \qquad (I)$$

which are useful as modulators of chemokine activity. The invention also provides pharmaceutical formulations and methods of treatment using these compounds.